

T H E

COMPLEAT Ship-Wright.

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Plainly and Demonstratively Teaching
the Proportion used by Experienced *Ship-Wrights*,
according to their Custom of Building; both
Geometrically and *Arithmetically* performed.

To which are added,

Certain Propositions in *Geometry*, the use of a *Diagonal SCALE*, to draw a *Draught*, with the Making,
Graduating, or Marking of a Bend of *Moulds*, and ordering
of the same: The Extraction of the *Square Root*, with a
Table of Squares.

A L S O,

A way of Rowing of *Ships*, by heaving at the *Cap-stain*,
useful in any *Ship* becalmed; with other things useful in that
A R T.

The *FIFTH EDITION*.

By EDMUND BUSHNELL, *Ship-Wright*.

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Tower-Hill, T. Passinger at the Three Bibles on London-Bridge, and E. Smith
at the Sign of the Bible in Cornhill, 1688.

THE COMPLETE Shipwright

The Shipwright and Dockwright, containing the
the proportion of the several parts of a Ship,
according to the Custom of Building, by
Geometry and Trigonometry performed.

By W. B. R. A. to which is added the
the proportion of the several parts of a Ship,
according to the Custom of Building, by
Geometry and Trigonometry performed.

ALSO
A way of Rowing of Ships, by the use of the
use of the several parts of a Ship, by
Geometry and Trigonometry performed.

THE FIRST EDITION

By W. B. R. A.

Printed by W. B. R. A.

TO THE R E A D E R.

Friendly Reader,

THe Matter contained in this Treatise, is written only for the good and profit of my Countrymen, who are still in that capacity that once I my self was; that is, ignorant of what they should know in their Trades, and desire Instruction; not that I presume to teach those long experienced Ship-wrights, whose Actions have declared their Abilities to the whole World, in their Building of so gallant and Serviceable a Fleet of Ships, as at present His Majesty the King of England is furnished withal, no King having the like either for Offence or Defence: yet their knowledge they desire to keep to themselves, or at least among so small a number as they can; for although some of them have many Servants, and by Indenture (I suppose) bound to teach them all alike the same Art and Mystery, that he himself useth; yet it may be he may teach some one, and the rest must be kept ignorant: so that those Ship-wrights, although bred by such knowing Men, yet they are able to teach their Servants nothing, more than to Hew, or Dub, to Fay a Piece when it is Moulded to his place assigned, or the like: but if occasion require, that the greatest part of these Men, by being Carpenters of Ships, or the like, may be removed from England to Virginia, or New-England, or the like Countries, where Timber is plenty for their use, yet through their ignorance, they durst not undertake such a Work: For their Sakes I have written this Book, wherein the Reader shall find Instructions sufficient for Moulding of any Ship or Vessel whatever, with the Mastings of them, drawing of Draughts, and all in a very plain and exact Method; which I am confident will be understood by the meanest capacities, if they can but read English, and have the benefit of a little Arithmetick, as Addition, Subtraction, Multiplication, Division. Be diligent, and I shall be thereby encouraged, if need be, to help thee farther in the Art. Farewell.

Thy Friend,

Edmund Bushnell.

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THE
COMPLEAT
Ship-Wright.

CHAP. I.

Of Geometrical Problems.

BEfore we proceed to draw the Draught of any Ship or Vessel, it will be necessary to be acquainted with some terms in *Geometry*: as to know what a Point and a Line meaneth, whichever Book treating of *Geometry* plainly teacheth, and therefore we shall pass that by, supposing that none will endeavour to study the Art of a *Ship-wright*, that is ignorant of these things: and therefore leaving these *Definitions*, I will proceed to some *Geometrical Problems* necessary to this Art.

PROBL. I.

How to draw a Parallel Line.

Parallel lines are such as are equidistant one from another in all parts, and are thus drawn. Draw a line of what length you please (according to your occasion) as the line *AB*, then open the compasses to what distance you please, or as your occasions require, and set one foot of the compasses towards one end of the given line, as at *A*, with the other



B

foot

foot make piece of an arch of a circle, over or under the given line, as the arch *C*, keeping the compasses then at the same distance, make such another arch towards the other end of the line, setting one foot in *B*, and with the other describe the arch *D*, then laying a Ruler to the outside of these two arches, so that it may exactly touch them, draw the line *CD*, which will be parallel to the given line *AB*, or equidistant; for so signifieth the word Parallel, to be of equal distance.

P R O B L. II.

How to erect a Perpendicular, from a Point in a Right Line given.

L Et there be a point given in the line *AB*, as the point *C*, whereon to raise a perpendicular.

Set one foot of the compasses in the given point *C*, and open them to what distance you please, as to the point *E*, make a little mark at *E*, and keeping the compasses at the same distance, turn them about, and make a mark at the point *F*, in the line *AB*: Then remove the compasses to one of those marks at *E* or *F*, and setting one foot fast therein, as at the point *F*, open the other foot wider, and therewith draw a small arch over the point *C*, as the arch *D*; then keeping the compasses at the same distance, remove them to *E*, and setting one foot in *E*, with the other foot draw another little arch, so as to cross the former arch, in the point *D*; through the crossing of these two arches *AD*, draw a line to the given point *C*, as the line *DC*, which shall be perpendicular to the line *AB*.

Divers other ways there are to raise a perpendicular, which I shall leave to the further practice of such as desire diversity of ways, and proceed to the raising of a perpendicular on the end of a line.

PROBL. III.

To raise a Perpendicular at the end of a Line.

Draw a line at pleasure, or according to your Work, as the line *AB*: on the end thereof as at *B*, set one foot of the compasses, and open them to what wideness you please, at to *C*, and keeping fast one foot at *B*, pitch one foot by adventure in *C*, then keeping one foot of the compasses in *C*, and at the same distance, remove the foot that was in *B*, to the point *D* in the line *AB*: then (keeping the compasses still at the same distance, lay a ruler to the points *D* and *C*, and with your compasses set off the distance from *C* to *E*: Lastly, draw the line *EB*, which will be perpendicular or square to the end of the given line *AB*.

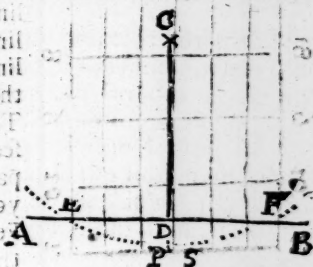


There are other ways to effect this, which I shall leave to farther practice of the Learner, this being the properest for our purpose.

PROBL. IV.

From a Point given, to let fall a Perpendicular upon a Line given.

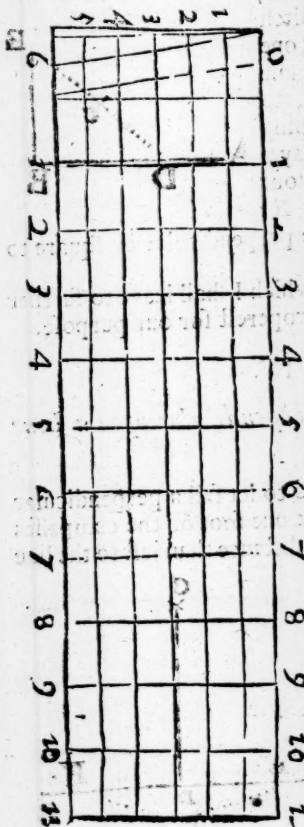
From the point *C*, let it be required to let fall a perpendicular upon the line *AB*, proceed thus: fix one foot of the compasses in the point *C*, and open them to a greater distance than just to the line *AB*, and make with the same extent the two marks *E* and *F*, in the given line *AB*, then divide the distance between the two points *E* and *F* into two equal parts in the point *D*, then lay a ruler to the given point *C*, and to the point *D*, and draw the line *CD*, which will be perpendicular to the given line *AB*.



C H A P. II.

Of your SCALE.

BEing perfect in the raising and letting fall of Perpendiculars, and in the drawing of Parallel lines, you may proceed to draught: but first I will unfold unto you the use of a Diagonal Scale of Inches and Feet, whose use is to represent a foot measure, or a Rule so small, that a Ship of 100 foot by the Keel, may be demonstrated on a common sheet of Paper, really and truly to be so many foot long, and so many foot broad, of such a depth, and of such a height between the Decks. And therein, the first thing to be considered, is, the length of the Platform, and of the Vessel you intend to demonstrate, to the end you may make your Scale as large as you can, because the larger the Scale is, the larger will the draught be, and so the measure of the demonstration will be the larger, and more easie to unfold. The Scale adjoining consisteth (as you see) of 12 feet in all, 11 thereof are marked with Figures downwards, beginning at 1, 2, 3, 4, and so to 11: the first at the top is sub-divided into Inches by Diagonal lines, as the distance between the first line of the Scale, and the first Diagonal line is one Inch, the second is two, and the third three Inches, and so to Six. The way to demonstrate the Scale, you see, is very easie: Draw seven lines parallel to each other, and of what length you please, to retain what number of Feet you please, then beginning at the top, set off with the Compasses the length



length of your feet both alow and aloft, then draw lines thwart the parallel lines, to every foot of the Scale, and set numbers to them, beginning at the second foot 1, and to the third 2, to the fourth 3, and so forward, leaving the first Foot to be divided into Inches by the Diagonal lines, as you see in the foregoing Scale.

CHAP. III.

Concerning the drawing your Draught upon Paper.

HAVING fitted your Scale ready, draw a line to represent the Keel of the Ship, as you see in the draught following of 60 foot long by the Keel, and 20 foot broad: the straight line that representeth the Keel is marked with *AB*. Then draw a line underneath of equal length, to signifie the bottom of the Keel. Then next you may proceed to the Stern-post, as the line *AC* will signifie the foreside or the inside thereof, racking the one quarter of his length aft, and for the length of the Stern-post it must be directed to the built of the Ship, as whether she be to be a deep Ship, or a shallow Ship, so that the draught of the water ought to be respected first, and then the lying of the Ports for the convenience of Ordnance, for that the upper transome of the Buttock, commonly is just under the Gun Room ports, to the upper edge of the said transome, we understand the length of the Stern-post, although if the Stern-post were continued to the height of the Tiller and another Transome fard there for the Tiller, to run on, it would steady the quarters of the Vessel very much, and do good service.

The Stern-post being drawn, we may proceed to draw the Stem, which in the following Draught is not so much racked as was the old proportion of *England*, which was the whole breadth of the Ship; for then it should be 20 foot, but it is no more than 15 foot, just $\frac{1}{2}$ of the breadth, for too much rack with the Stem doth a great deal of damage to any Ship, if we consider that in this small Vessel, had we given 5 foot more rack, all the weight of the Ship's Head, and Bolt-sprit, Foremast, Manger Halves, Brest-hooks aloft, had been so much farther forward, where there would have been want of Body,

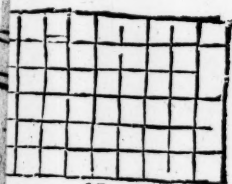
to lift it, so that it must of necessity be detriment to the Vessel when she saileth against a head-sea, and a great strain to her. Now it will be very good to spend as much of this rack as we can under the water, for it will help the Ship to keep a good Wind, by giving her something more Body in the Water.

Next draw the water-line, in the following draught signified by the pricked line; it is drawn to 9 foot height afore, and to 10 foot height abaft from the upper edge to the Keel, and higher abaft than afore, for the most Ships sail by the Stern, and also for that the Guns should lie something higher abaft than afore from the water.

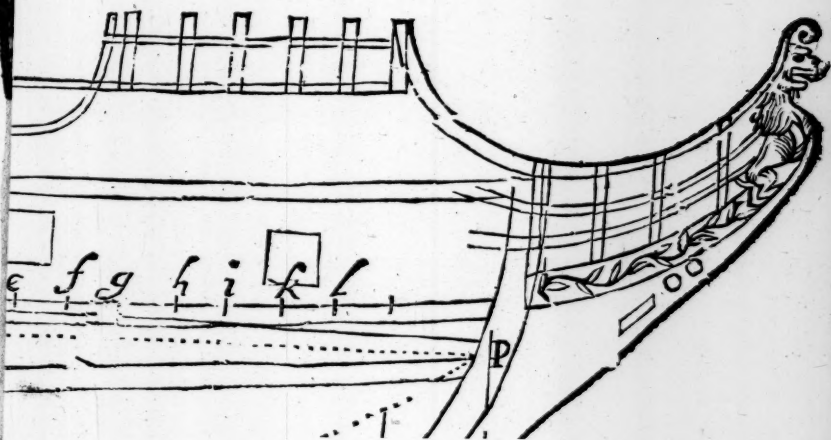
Then proceed to hanging of the Waals, and here you see the lower Waal drawn from the head of the Stern-post, to signifie that it should lie against the end of the Transome, that the Transome Knees might be bolted to the Waals without board to one foot and an half under the Water-line, a little before the middle of the Water-line, and at 9 foot high on the Stem, and the next Waal parallel to the lower Waal, one foot and an half asunder, so that the upper Waal will lie just at the waters edge, in the mid-ships; the upper edge of the Gun-deck will lie one foot above the water-line abaft, and half a foot above water on the Stem; so then letting the lower sell of the Ports be two foot from the Gun-decks, the lower edge of the Ports will be three foot from the water abaft, and two foot and an half afore, in the middle of the Gun-deck 2 foot 9 inches, sufficient for so small a Vessel, a greater Vessel would require to have the Guns something farther from the water: then if another Waal be required, first set off the Ports in their places, that the Waal may lie above the Ports, or else he would be cut with the Ports in pieces, the upper Deck with height respecting the bigness of the Ship, having respect to not over-building small Ships, to damage their bearing of Sails.

Then for the Head, the length of the Knee would be two thirds of the breadth, so then the Knee of the Head in this Draught will be 12 foot 8 inches long, and for his place, as low as conveniently he can, provided that the Rails of the Head come not foul of the halshols, because that in placing of the Knee low, giveth room to round the Head, and steers it to content. The place of the Knee will be at, or very near, the upper Waal, the upper edge of the Knee against the upper edge of the upper harping, which will be very well for the lower

AB
AC
DE
OP
EO
O



35



AB the Keel
AC the Stern Post
DE the rising line aft
OP a rising line forward
EO Dead Rising or flat
O with a Cypher mark is the
flat a floor

FG. A line parallel to the
bottom of the Keel AB
at half breadth or 10 feet below
called a Ram-line

11 M. the half length of j floor
the work shifts 4 feet square straight line
12 M. A crooked line within it signifying the
narrowing of the floor

1.2. a crooked line within it signifying
the narrowing of the floor

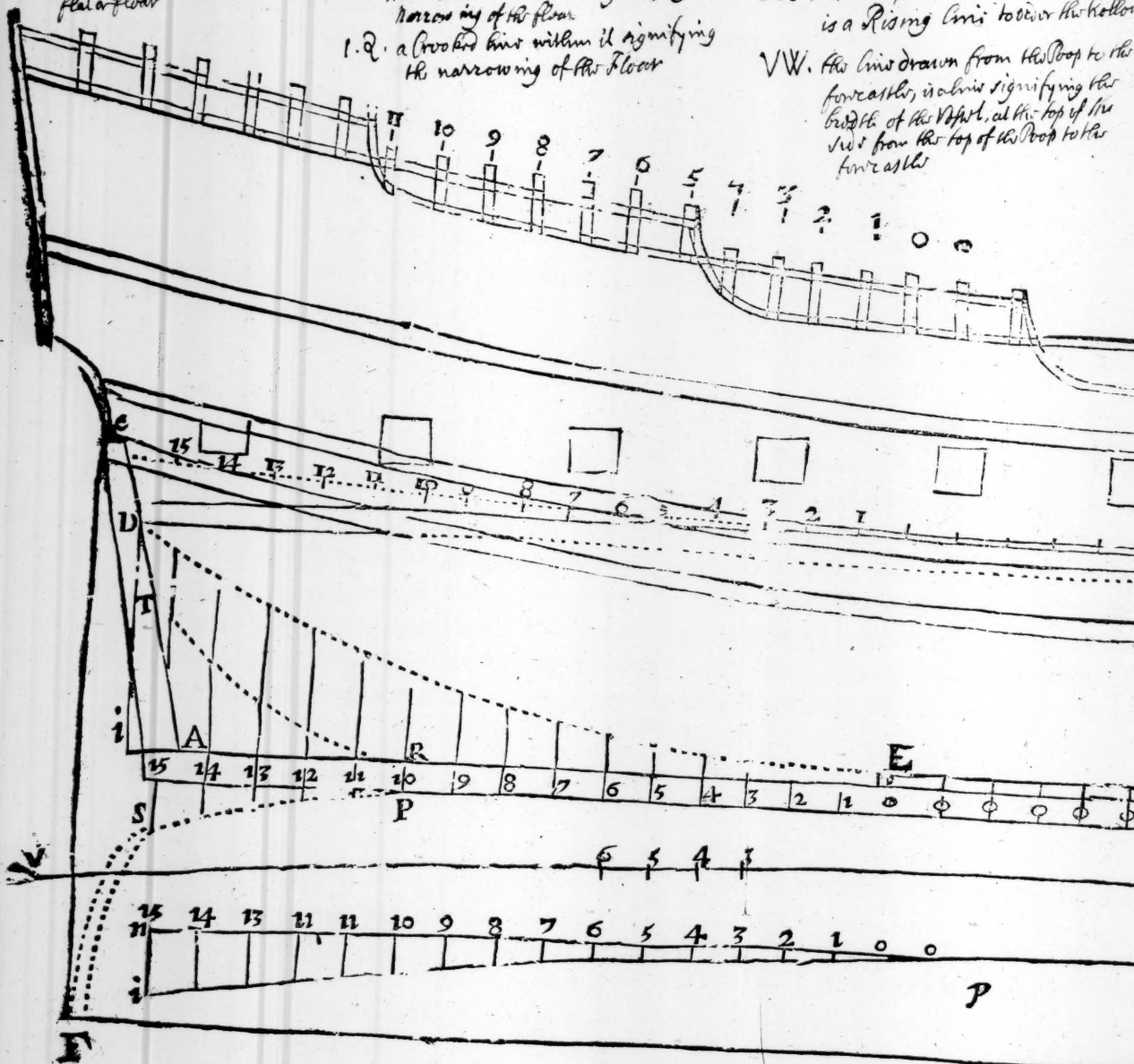
GG. The Sweep of the Harping by
length of the Vignol

FS. the length of the Transom which

SP is the narrowing line aboff at the br

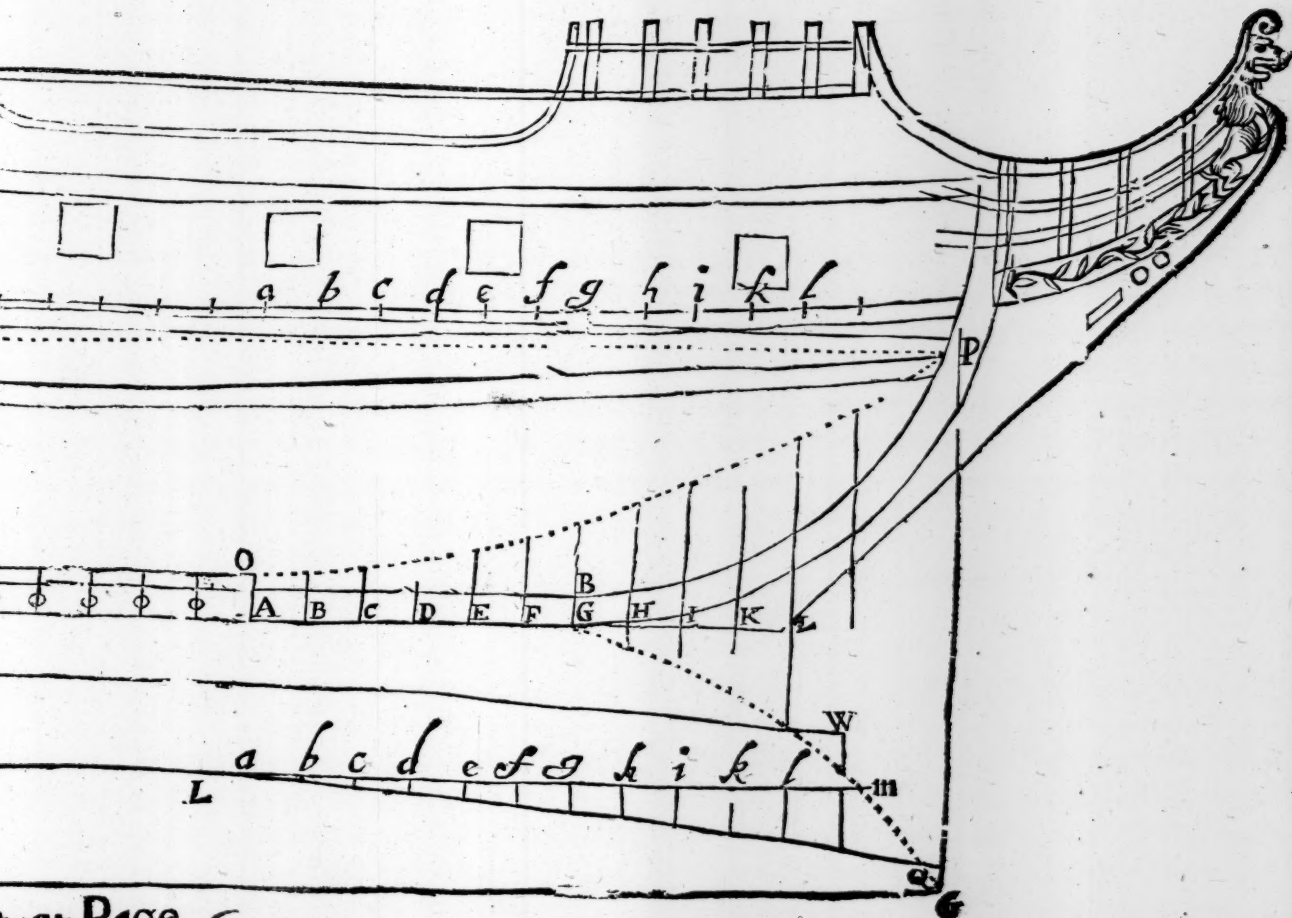
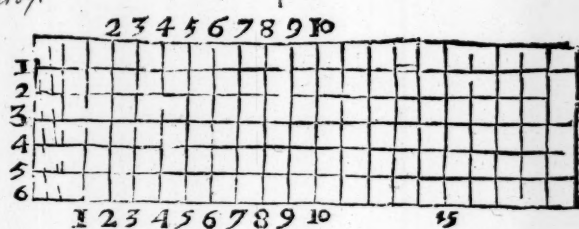
TR. A crooked prickled line within the Ke
is a Rising line to view the hollow

VW. the line drawn from the Prop to the
forecastle, is aboff signifying the
breadth of the Vignol, at the top of the
Keel from the top of the Prop to the
forecastle



Place this Draught at P

op to the
ing the
of the
to the





lower Cheeks of the Head to be faied againſt; for by that means they will be clear of any Seam to avoid Leakings, and will very well bolt the end of the harping, if a Breſt-hook be faſtned alſo within board againſt them, it will very well faſten all together.

Then for the ſteeving of him and rounding the Knee, a regard muſt be had to the lying of the Boltſprit, leaving room enough for the Lyon and Scrowl under the Boltſprit. Then for the rounding of the Rails, round them moſt at the after ends.

For the heights between Decks and Steerage, Cabine, Fore-Caſtle, thoſe heights are commonly mentioned in contract by the Maſter or Owners building.

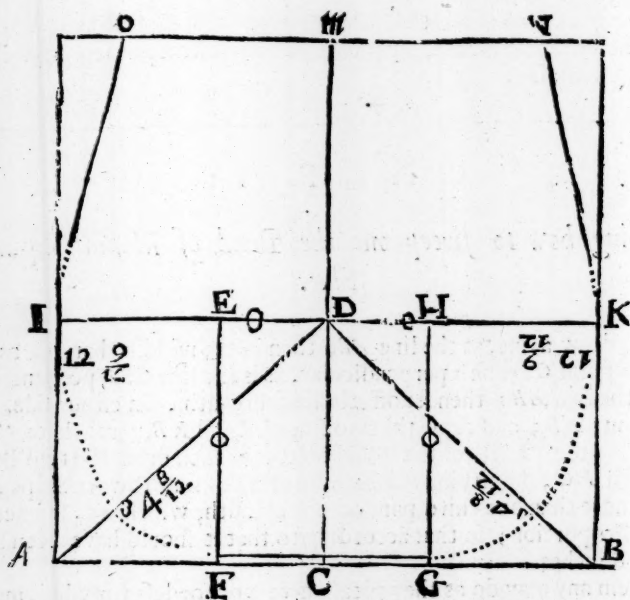
C H A P. I V.

Shewing how to ſweep out the Bend of Moulds upon a Flat.

Firſt, draw a line, as the line *AB*, then in the middle thereof, as at the point *C*, raiſe a perpendicular, as is the line *CM*, perpendicular to the line *AB*; then ſet off the half breadth, on either ſide, at the points *AB*; and draw the two lines *IA*, and *KB*, parallels to *CD*, ſignifying the breadth of the Veſſel 20 foot; then draw the two lines *EF*, and *HG*, ſignifying the breadth of the Floor thwart Ships, 8 foot, more than one third part of the breadth, which was formerly an old Proportion; ſo that according to that it ſhould have been but 6 foot 8 inches.

Herein any may do as they pleaſe, give more or leſs; my judgment is, rather more than leſs: for that it maketh a Veſſel to carry more in Burden, and I conceive, if it be well ended forward, it will not damage the Sailing; I alſo think, it doth ſtiffen a Veſſel on this account. Our *English* Veſſels have been uſed to have their breadth lying at the height of the half breadth, then obſerving; breadth for the length of the Floor thwart Ships, it maketh the Veſſels Body to be very near a Circle, as is a Caſk, which cauſeth ſuch Veſſels to be eaſie

case to flew in the Water; yet I would not exceed neither, nor run into extreame herein, but if I were to make a Vessel stiff, I would that the half Breadth be more than the draught of Water, which causeth that the Body be stronger in the Water, and will not flew so easily. Now to sweep out the Sides under Water, I draw the *Diagonal* lines *DA*, and *DB*, then I divide the *Diagonal* lines into 9 parts, and



set off 2 of them from the Corners *A* and *B* to the points *e*, then I set off the *Dead Rising*, which is of 4 Inches, one Inch to a Foot, for half the breadth represented in the Figure above, by the little line parallel to *FG*: from which *Dead Rising*, take with the Compasses the Distance that will draw a piece of an Arch from *f* to *e*, and so as one foot of the Compasses stand in the line *EF*, and exactly touch the points at the
Dead

Dead Rising, at *f* or *g*, and touch also the points *e* over which point sails at \odot , in *EF* or \odot in *HG*, wherewith I describe the Arch *eF*, or *eG*, which is by the Scale in the Draught 4 foot 8 inches: then for the other part of the Side upwards, seek for a point in the breadth line *IK*, at which, if one foot of the Compasses be set, and the other foot opened to the extream Breadth, will also draw, or signifie an Arch to meet with the other Lower Arch, on the *Diagonal* line at *e*, which is at the points \odot and \odot ; thus the point \odot , between *D* and *K*, near *H*, Sweepeth the contrary Side *le*, and so the point \odot , between *DI*, near *E*, Sweepeth the contrary side at *K*; extend the same Sweep also above the Breadth line above Water 3 or 4 Foot, the length of this Sweep is 12 Foot 9 Inches: then set off the Tumbling Home, at the Height of the two first Haanfes, at the Main Mast, and fore-castle, 2 foot of a side; then draw a line from the said 2 Foot of Narrowing, at the points *o v*, till it break off on the back of the Sweep, on either side. This kind of Demonstration I conceive most suitable to our following discourse of *Arithmerical* Work: I could have cited other ways, but I judge this way sufficient.

C H A P. V.

The Description of the Rising Lines aftward on, and forward on; with the Narrowing Lines, and Lines of Breadth: As also the Narrowing Lines at the top of the Timbers.

Draw a Hanging line on the Draught, from the Keel, from the middle of the Keel to the height of the Water line, on the Post which will be the Rising line, as the line *DE*; this line *DE* is supposed to be swept, or drawn by a *Semidiameter* of a Circle, extended on a Perpendicular raised at the point *E*, for if it be shorter than such a *Semidiameter* of the true Circle, it will make a fuller line than it should be, and so must not be so long, or else it will make a breach at

the beginning of the line; this, if the Center be supposed to be A-baft such a Perpendicular, that should draw a Rising line Abaft, I say, that it will shorten the Rising line, and make it fuller than it should be; or then if it be farther forward, it will be straighter than a Circle, and also be a breach at the beginning of the Rising line; Afore it should be a Circle, I say, whose *Semidiameter* will be on the Perpendicular line, at the beginning of any such Rising line, on the Heel, either Afore or Abaft, and the like ought to be for all other crooked lines, as the narrowing lines Abaft, or Afore, or at the Narrowing of the Floor, or other Circular lines, as Hanging of Waals, and the like; the way whereof I shall describe, to find the lengths of all such Sweeps by Arithmetick; as also the true Rising, Narrowing of any Timber, according to the exact pieces of Circles, very useful for the setting of Bows, to try whether they hang to a true Sweep or no: I shall demonstrate it, I say, in the following Discourse, and in this place end what I intend to say. For Demonstration then, At $\frac{1}{4}$ of the Keel forward I draw a Rising line forward to the height of the Water line forward on the Stem, as you see the line *op*; and the little line, between these two lines, parallel to the inside of the Keel, marked *Eo*, is the dead rising 4 inches high, as in the bend of Moulds it is parallel to *FG*, the height of the breadth from the Mid-Ship forward, is the lower Edge of the upper Waal; but Aftward on it is the pricked line, between the Water line and the lower Waal, on the Post, which runneth forward to the edge of the Waal, and hath Figures set to it, to signify the places of the Timbers marked 1, 2, 3, 4, 5, to 15; as you see answers to the Figures on the Keel: and the Letters set to forward on, signify the places of the Timbers forward, marked *ABCD* to *L*, in the middle of the Vessel: the places marked with a Cypher, signify the Flats, which have only Dead rising, although they ought to have (some of them) something more Dead rising than each other; and those that have least, to be placed in the middle of the rest, that so there be no Clings in the Buldge, but that it have also a little Hanging in it, it will seem fairer: Then I draw a straight line, parallel to the bottom of the Keel, as is the line *FG*, parallel to the line *AB*, the Keel, and distant 10 foot by the Scale, which is the half breadth of the Vessel; for this line

line signifieth a line stretched from the middle of the Stern-post to the middle of the Stem, called by *Ship-wrights*, a Ram-line: Parallel to this Middle-line I draw another line straight, marked *nm*, and is 4 Foot afunder from the Middle-line, to signifie the half length of the Floar thwartships, as in the Bend of Moulds *EF* is distant from *DC* 4 Foot: Then I draw a Crooked-line Abaft, within this line *nm*, to signifie the narrowing of the Floar, to bring, or form the Vessels way Abaft, as you see the line *ik*; Abaft and Afore it is represented by the line *Q*: Then here in this Draught I draw a Sweep, or a piece of a Circle from the Point *G*, the mark of the Timber *G*, on the Keel, to the half breadth of the Stem to the point *G* on the Stem, signifying the Sweep of the Harping, and is Sweep by the breadth of the Vessel 20 Foot; the piece of the pricked Circle Abaft at the Stern, which is drawn by a Centre on the line *FG*, is the length of the Transome thwart the Stern, as is the Arch *FS*, the length whereof is 8 Foot, which doubled is 16 Foot, for the whole length; which is $\frac{1}{2}$ of the breadth 20 Foot, the length of the Sweep that Sweepeth *T* is the length of the Stern-post to the bottom of the Keel 14 Foot $\frac{1}{2}$, then the Crooked line from the end of the Transome, or from the point *S*, and toucheth the Keel at the point *p*: This Arch *Sp*, is the narrowing line Abaft at the breadth, and the crooked pricked line within the Keel, marked with *TR*, is a Rising line, to order a hollow Mould by the Timbers, are placed at 2 Foot Timber and Room, as you may see by the Scale, the line drawn from the Poop to the Fore-Castle, marked by the Letters *VW*, is a line signifying the breadth of the Vessel, at the top of the side, from the top of the Poop to the Fore-Castle, the top of the Poop is in breadth 10 Foot, half the breadth at the Beam; the use of this line is in ordering of the Moulds, to steady the Head of the Top-timber Mould, to find his breadth Aloft.

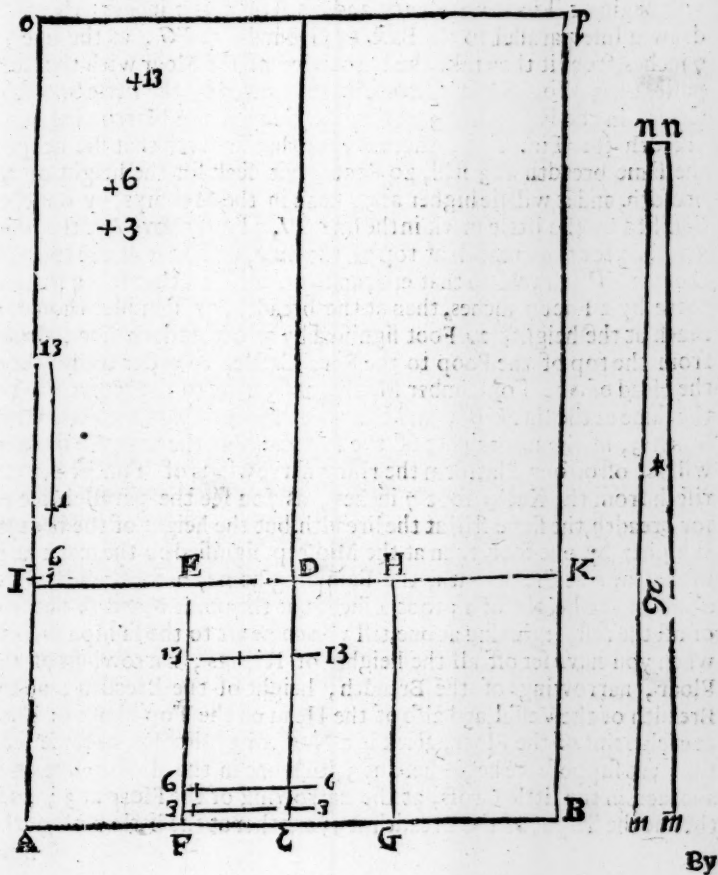
CHAP. VI.

Shewing the Making and Graduating, or Marking of the Bend of Moulds.

R Epair to some House that hath some Room or other broad enough to demonstrate the breadth of the Vessel, and height enough for the top of the Poop in the length of the Room; or else if you cannot find such a Room convenient, lay boards together; or planks, that may be large enough for your business, as in the following *Scheme* you see: First, a long square made for the breadth of the Vessel, as in the following Figure *IABK*: then make the Moulds by their Sweeps, and make Sirmarks to them for laying them together in their true places, first the Mould, for the Floar being made, you may make a Sirmark by the line *EF*, on the head of the Floar Mould, and another on the foot of the Naval Timber Mould, at the same place to signifie that those two marks put together, they are in their true places, and will compare so when any Timbers are Moulded by them: those Sirmarks must also be marked off on the Timbers, and so in putting the Timbers up in the frame, a regard being had to compare Sirmarks with Sirmarks, each Timber will find its own place, and come to his own breadth, and give the Vessel that form assigned her by your *Draught*, if it be wrought by it, and so for all the other Moulds.

In making your Moulds, that they may be smaller and smaller upwards, and not all of a bigness, you may measure the depth of the Side in the Midships circular, as it goeth from the Keel to the top of the Side, as here the Side, as it Roundeth, is 26 foot, and in depth at the Roundheads, or at the end of the Floar, is one Foot, as *mm*; and at the other end, at the head of the Timber is but half a Foot, as at *nn*, so then drawing two lines, as the lines *nm*, represents the diminishing of the Moulds in thickness upwards, as those two lines representeth; as if you would find the thickness of the Timbers at the breadth, take your 2 Foot Rule, and measure the length from the end of the Floar

Floor at the point *F* to *I*, at the breadth in the crooked body, and it is 11 Foot 9 Inches, signified at the Sirkmarks there, those two lines shew the thickness to be 9 Inches; and so thick ought the Moulds to be at the breadth of the Vessel.



By this Proportion the Moulds being made and Sirmarked to the Body of the Vessel, and that they must be marked, or ordered, to find the decrease of her bulks body in the Midships, and to come to her way Aft, that the Water may pass to her Rudder to make her steer, repair to the *Draught*, and first set off her Risings thus: *Example*, We will begin at Timber 3 Aft, and his Rising is 7 inches: therefore draw a line parallel to the Base, or Ground-line *FG*, as the line 33, 7 inches, from it then take the narrowing of the Floor with the Compasses off 3 also, and it is here 4 inches shewed by the little Spot, or Cross, in the Rising line 33, then seeking for the Narrowing at the breadth for Timber 3, there is none that sheweth that she keepeth the same breadth at 3 still, 20 Foot, but seek for the height of the breadth, and it will lie higher at 3, than in the Midships, by 6 inches, signified by the little mark in the line *AI*, a little above *I*, at the point 3; then for the breadth at top of the Side, find that at the top 3, in the line *VW*, drawn to that end, and you will find that it is narrower there by 2 Foot 7 inches, than at the breadth, or Tumbleth home, so much at the height, 24 Foot signified by an occult dark line, drawn from the top of the Poop to the Fore-Castle, to order the height of the Head of the Top-timber Mould, answering to the Narrowing of the same at the line *VW*; and this point for 3 falls at the little Cross Mark 3, in the upper part of the Figure: For the next *Example* we will set off on our Platform the rising narrowings of Timber 6, and 6 riseth from the Keel 1 foot 7 inches, as you see the parallel line 66 for breadth, the same still at the breadth, but the height of the breadth is higher by one foot, than at the Midship, signified by the mark at 6, in the line: at the breadth, the Tumbling home, 1 foot 7 inches and a half, at the height of 25 foot 4 inches, at the point 6, and so proceed of all the rest, beginning at one, till you come aft to the fashion Pieces; when you have set off all the heights of Risings, narrowings of the Floor, narrowings of the Breadth, height of the Breadth, at the Breadth of the Vessel, and also of the Head of the Top-timber: Then at each point of the Floor, stick in a Nail, or a Gimblet, or some such thing; as suppose we begin here at 3, stick one in the Midship line at 3, another in the little Cross, at the narrowing of the Floor at 3; another at the height of the Breadth at 3; another at the little cross, at the head

head of the Top-timber for 3, then if you have a lower futtock Mould, and an upper futtock Mould, otherwise a navel Timber Mould, and a futtock Mould, nail them together with small Nails, and lay the Sirmarks of the floor Mould, and futtock Mould to the Gimblet that sticketh at the shortning of the floor, for by this means the floor Mould and futtock Mould is haled downward: then make a mark at the cross, in the Midship line *CD*, setting to the Mark of 3 for Timber 3, which will be the shortning of the floor; then be sure the Navel Timber Moulds touch the Gimblet at the breadth, and at the narrowing of the Floor, keeping the lower Sirmark thereto; and make a mark on the futtock Mould, at the upper Gimblet, for the rising aloft lifteth up the Moulds higher; and if there be any Crossing at the foot of the Navel Timber, and Head of the Floor Mould, mark it, and set to the mark 3 to it, that you may know to lay them together again, and keeping the futtock Mould fast, lay to the Top-timber Mould the breadth Sirmark of the Top-timber Mould, to the Gimblet at the breadth, so have you no more Sirmarks on the Top-timber Mould but one, and guide the head of him till a line stretched from the Cross, at the head of the Top-timber, till it compareth with the right part of the Top-timber Mould, then regard the Crossing of the foot of the Top-timber Mould, and the back of the futtock, and mark it, setting to the proper Mark 3 to it, that laying those marks together again, they may find their own places again, so having finished for this Room 3, take up the Moulds, and remove the Gimblets to the next, as to 6, here in our *Example*, and stick the Gimblets at all the marks of 6, then lay down the Moulds again, laying down the floor Mould to the Sirmark of 6, on the narrowing of 6, and to the Gimblet, sticking on the Midship line of *DC*, and right on the same line, at the crossing, make a mark on the floor Mould, which will be the narrowing of the floor; then lay down the futtock Mould, the Sirmark on the foot to the Gimblet, on the narrowing of the floor, and keeping the Mould to touch the Gimblets at both places, make a mark for the breadth Sirmark at 6, on the futtock Mould, and set to 6; then lay down the Top-timber Mould, the breadth Sirmark thereof to the Gimblet, sticking at the height of the breadth, that the backside of the upper end may range fair, by a right line from the cross at the upper end of the Top-timber.

timber at 6, by the back of the Top-timber Mould, a straight line may compare therewith, then keeping fast the Moulds so till you have marked the crossing of the foot of the Top-timber Mould, by the back of the futtock, mark it on the foot of the Top-timber Mould, and set to the mark of 6, so that when you are in any other place, as in the Woods a hewing of a Frame, where you hew to every place his Timber, you may be able to lay your Mould together, and mould it according to your *Draught*: We will lay down the taking of one bend of Timbers more after, where the breadth is narrowed, as at Timber 13, take his rising off, and measure it by the Scale, and it will be 6 foot 8 inches, which set off on your Platform, and draw thereto a Parallel line, to the Ground line *AB*, as is the line 13, 13, then take off the narrowing of the floor, as at 13, it is 2 foot 2 inches; set that off on the line 13; from the line *EF*, as at the little cross thereon, then take off the narrowing of the breadth at 13, and it will be 8 inches; draw therewith a little parallel line, parallel to *IO*, as is the parallel line 13, 13, then seek the height of the breadth, as at 13, it will be from the upper edge of the Keel 12 foot 3 inches, and crosses the parallel line, at the lower end of it, just then for the tumbling of the Top-timber it will be 3 foot 3 inches, and at the height of 27 foot 7 inches, at the little Cross 13: Now, for the order of the hollow Mould, the little round piece of an Arch, in the Skegg of the Vessel, as it were, take off all the Risings, and mark them on the Rising Staff, on one edge, that they may be known from the other Risings; as here, for Timber 13, take off the hollow Rising, which will be at 1 foot 10 inches, set it off on the rising Staff, at 1 foot 10 inches from one end, and the use of it will be in Moulding; set of the height of this hollow Rising, on the middle line of the Timber, when the Moulds are laid to pass, and strike a line from this Rising, on the middle line until it break off on the back of the Moulds, then lay the hollow Mould to the lower part of the breech of the Timber, and at the half breadth of the Keel, and so bear in the other end till it just touch the straight line, made by the hollow Rising, and the back of the Moulds, and this mouldeth the lower part, or breech of the Timber, and bringeth in the hollow very fair; the same orders may be observed afore, as abast, on the other side of the Moulds, and marked with Letters, to be known

known from them abaft: Then for the height of your Waals, you may make a mark at every third or fourth Timber, which you resolve to make frame Timbers; I say, you may make a mark at every third or fourth Timber, for the height of the upper edge, or lower edge of the Waal, and so bring on the Waal fair by those marks on the one side, and with a level find the height of the other side by the former.

Now I have briefly touched the Demonstration of a Ship, by Projection; I shall now come to an *Arithmetical* way, far surpassing any Demonstration for exactness.

CHAP. VII.

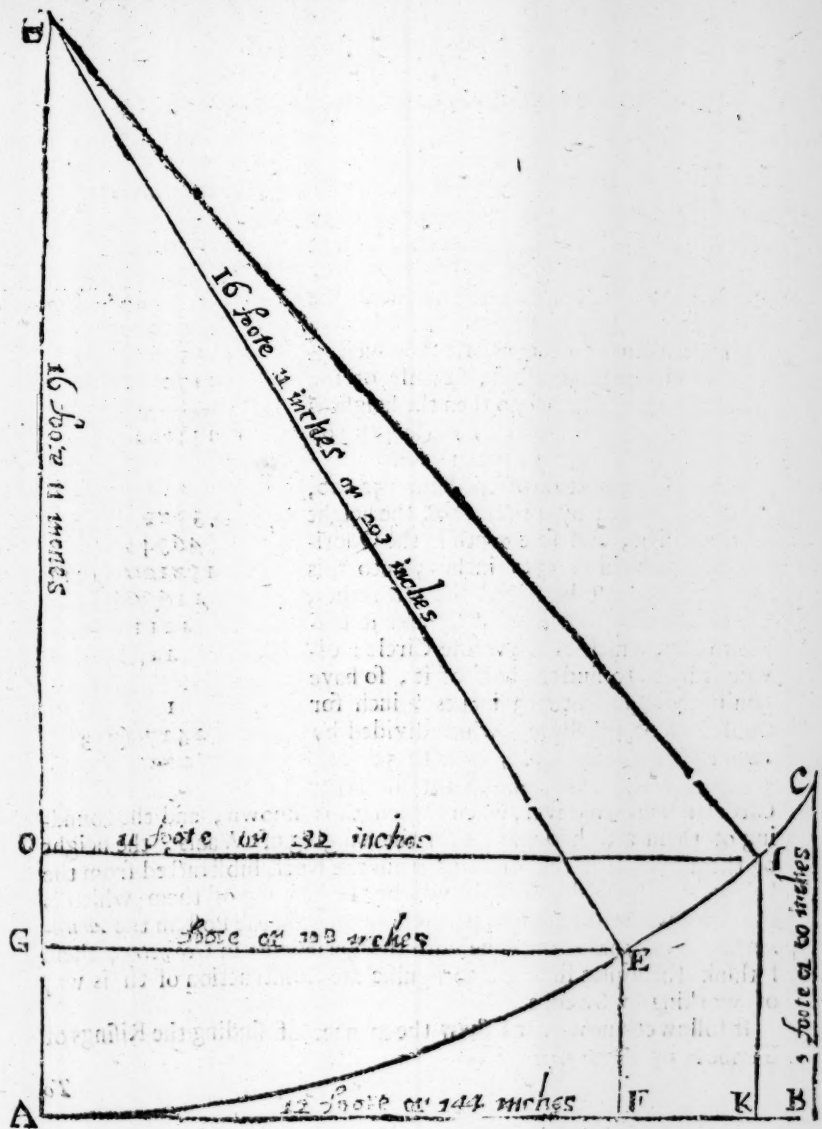
Arithmetically shewing how to frame the Body of a Ship by Segments of Circles: being a true way to examine the truth of a Bow.

L Et *AB* represent the length of a Rising line 12 Foot long, or 144 inches, the height whereof let be *BC*, 5 Foot, or 60 inches, to find the side *DE*, or *DA*, the Radius of the Circle *AC*, whereto *AD* is the Semidiameter; multiply the side *AB* 144 inches in it self, and so cometh 20736, which sum divide by the side *BC*, the height of the rising 60 inches, and so cometh 345, and $\frac{36}{5}$ which is abbreviated $\frac{3}{5}$; unto this $345 \frac{3}{5}$ must be added, again the height of the Rising, the side *Be*, 60, which make $405 \frac{3}{5}$ of an inch, which is the whole Diameter of the Circle, the half whereof is $202 \frac{1}{2}$ inches, and something more, near $\frac{3}{4}$, therefore we will avoid the fraction, and account 203 inches, or 16 Foot 11 inches, which is the length of the Sweep, or the side *DE*; and so in all other Sweeps given whatsoever, the Rule is general, and holds true in all things: as to find the Sweep at

$$\begin{array}{r}
 144 \\
 \times 144 \\
 \hline
 576 \\
 576 \\
 \hline
 20736 \\
 \hline
 23 \text{ (3)} \\
 20736 \text{ (345)} \\
 \hline
 6000 \\
 \hline
 66
 \end{array}$$

once, that will round any Beam, or other piece of Timber that is to be Sweept, remembring, that if it be a Beam, you are to find the Sweep you take but the half of his length.

Example, As if the Beam be 30 Foot in length, and to round one Foot, you must work by 15, the half length of the Beam; and turn 15 Foot into Inches, by Multiplying 15 by 12, so cometh 180 Inches: remember the length of the Rising line, if it be to find the Sweep, it must be Multiplied by it self, or the half length of the Timber must be Multiplied by it self, as 180 by 180, so cometh 32400, which must be divided by 12 the rounding, cometh in the Quotient 2700, to which must be added the 12 again, the rounding of the piece, and so it is 2712 the whole Circle, the half of this 2712 is 1356 for the length of the Sweep, and so in all other matters where the Sweep is required. This I read in Mr. *Gunter's* Book, where he calls it the half Chord, being given, and the Versed sine, to find the *Diameter*, and *Semidiameter* of the Circle thereto belonging: Now this half Chord in our Work is the length of the Rising line, and the height of the Rising on the Post is that in our Work, which he represents by the name of the Versed sine; where remember to multiply the length of the rising line by it self, if it be a Rising line, and divide by the height of the Rising, and to the Division add again the height of the Rising, so have you always the whole Circle, divide it by 2, so have you the length of the Sweep.



By this Proportion the Moulds being made and Sirmarked to the Body of the Vessel, and that they must be marked, or ordered, to find the decrease of her bulks body in the Midships, and to come to her way Abaft, that the Water may pass to her Rudder to make her steer, repair to the *Draught*, and first set off her Risings thus: *Example*, We will begin at Timber 3 Abaft, and his Rising is 7 inches: therefore draw a line parallel to the Base, or Ground-line *FG*, as the line 33, 7 inches, from it then take the narrowing of the Floor with the Compasses off 3 also, and it is here 4 inches shewed by the little Spot, or Cross, in the Rising line 33, then seeking for the Narrowing at the breadth for Timber 3, there is none that sheweth that she keepeth the same breadth at 3 still, 20 Foot, but seek for the height of the breadth, and it will lie higher at 3, than in the Midships, by 6 inches, signified by the little mark in the line *AI*, a little above *I*, at the point 3; then for the breadth at top of the Side, find that at the top 3, in the line *VW*, drawn to that end, and you will find that it is narrower there by 2 Foot 7 inches, than at the breadth, or Tumbleth home, so much at the height, 24 Foot signified by an occult dark line, drawn from the top of the Poop to the Fore-Castle, to order the height of the Head of the Top-timber Mould, answering to the Narrowing of the same at the line *VW*; and this point for 3 falls at the little Cross Mark 3, in the upper part of the Figure: For the next *Example* we will set off on our Platform the rising narrowings of Timber 6, and 6 riseth from the Keel 1 foot 7 inches, as you see the parallel line 66 for breadth, the same still at the breadth, but the height of the breadth is higher by one foot, than at the Midship, signified by the mark at 6, in the line: at the breadth, the Tumbling home, 1 foot 7 inches and a half, at the height of 25 foot 4 inches, at the point 6, and so proceed of all the rest, beginning at one, till you come ast to the fashion Pieces; when you have set off all the heights of Risings, narrowings of the Floor, narrowings of the Breadth, height of the Breadth, at the Breadth of the Vessel, and also of the Head of the Top-timber: Then at each point of the Floor, stick in a Nail, or a Gimblet, or some such thing; as suppose we begin here at 3, stick one in the Midship line at 3, another in the little Cross, at the narrowing of the Floor at 3; another at the height of the Breadth at 3; another at the little cross, at the head

head of the Top-timber for 3, then if you have a lower futtock Mould, and an upper futtock Mould, otherwise a navel Timber Mould, and a futtock Mould, nail them together with small Nails, and lay the Sirmarks of the floar Mould, and futtock Mould to the Gimblet that sticketh at the shortning of the floar, for by this means the floar Mould and futtock Mould is haled downward: then make a mark at the cross, in the Midship line *CD*, setting to the Mark of 3 for Timber 3, which will be the shortning of the floar; then be sure the Navel Timber Moulds touch the Gimblet at the breadth, and at the narrowing of the Floar, keeping the lower Sirmark thereto; and make a mark on the futtock Mould, at the upper Gimblet, for the rising aloof listeth up the Moulds higher; and if there be any Crossing at the foot of the Navel Timber, and Head of the Floar Mould, mark it, and set to the mark 3 to it, that you may know to lay them together again, and keeping the futtock Mould fast, lay to the Top-timber Mould the breadth Sirmark of the Top-timber Mould, to the Gimblet at the breadth, so have you no more Sirmarks on the Top-timber Mould but one, and guide the head of him till a line stretched from the Cross, at the head of the Top-timber, till it compareth with the right part of the Top-timber Mould, then regard the Crossing of the foot of the Top-timber Mould, and the back of the futtock, and mark it, setting to the proper Mark 3 to it, that laying those marks together again, they may find their own places again, so having finished for this Room 3, take up the Moulds, and remove the Gimbles to the next, as to 6, here in our *Example*, and stick the Gimbles at all the marks of 6, then lay down the Moulds again, laying down the floar Mould to the Sirmark of 6, on the narrowing of 6, and to the Gimblet, sticking on the Midship line of *DC*, and right on the same line, at the crossing, make a mark on the floar Mould, which will be the narrowing of the floar; then lay down the futtock Mould, the Sirmark on the foot to the Gimblet, on the narrowing of the floar, and keeping the Mould to touch the Gimbles at both places, make a mark for the breadth Sirmark at 6, on the futtock Mould, and set to 6; then lay down the Top-timber Mould, the breadth Sirmark thereof to the Gimblet, sticking at the height of the breadth, that the backside of the upper end may range fair, by a right line from the cross at the upper end of the Top-timber.

timber at 6, by the back of the Top-timber Mould, a straight line may compare therewith, then keeping fast the Moulds so till you have marked the crossing of the foot of the Top-timber Mould, by the back of the futtock, mark it on the foot of the Top-timber Mould, and set to the mark of 6, so that when you are in any other place, as in the Woods a hewing of a Frame, where you hew to every place his Timber, you may be able to lay your Mould together, and mould it according to your *Draught*: We will lay down the taking of one bend of Timbers more after, where the breadth is narrowed, as at Timber 13, take his rising off, and measure it by the Scale, and it will be 6 foot 8 inches, which set off on your Platform, and draw thereto a Parallel line, to the Ground line *AB*, as is the line 13, 13, then take off the narrowing of the floor, as at 13, it is 2 foot 2 inches; set that off on the line 13, from the line *EF*, as at the little cross thereon, then take off the harrowing of the breadth at 13, and it will be 8 inches; draw therewith a little parallel line, parallel to *IO*, as is the parallel line 13, 13, then seek the height of the breadth, as at 13, it will be from the upper edge of the Keel 12 foot 3 inches, and crosses the parallel line; at the lower end of it, just then for the rambling of the Top-timber it will be 3 foot 3 inches, and at the height of 27 foot 7 inches, at the little Cross 13: Now, for the order of the hollow Mould, the little round piece of an Arch, in the Skegg of the Vessel, as it were, take off all the Risings, and mark them on the Rising Staff, on one edge, that they may be known from the other Risings; as here, for Timber 13, take off the hollow Rising, which will be at 1 foot 10 inches, set it off on the rising Staff, at 1 foot 10 inches from one end, and the use of it will be in Moulding; set of the height of this hollow Rising, on the middle line of the Timber, when the Moulds are laid to pass, and strike a line from this Rising, on the middle line until it break off on the back of the Moulds, then lay the hollow Mould to the lower part of the breech of the Timber, and at the half breadth of the Keel, and so bear in the other end, till it just touch the straight line, made by the hollow Rising, and the back of the Moulds, and this mouldleth the lower part, or breech of the Timber, and bringeth in the hollow very fair; the same orders may be observed above, as above, on the other side of the Moulds, and marked with Letters to be known

known from them abaft: Then for the height of your Waals, you may make a mark at every third or fourth Timber, which you resolve to make frame Timbers; I say, you may make a mark at every third or fourth Timber, for the height of the upper edge, or lower edge of the Wail, and so bring on the Waal fair by those marks on the one side, and with a level find the height of the other side by the former.

Now I have briefly touched the Demonstration of a Ship, by Projection; I shall now come to an *Arithmetical* way, far surpassing any Demonstration for exactness.

C H A P. VII.

Arithmetically shewing how to frame the Body of a Ship by Segments of Circles: being a true way to examine the truth of a Bow.

Let *AB* represent the length of a Rising line 12 Foot long, or 144 inches, the height whereof let be *BC*, 5 Foot, or 60 inches, to find the side *DE*, or *DA*, the Radius of the Circle *AC*, whereto *AD* is the Semidiameter; multiply the side *AB* 144 inches in it self, and so cometh 20736, which sum divide by the side *BC*, the height of the rising 60 inches, and so cometh 345, and $\frac{36}{60}$ which is abbreviated $\frac{3}{5}$; unto this 345 $\frac{3}{5}$ must be added, again the height of the Rising, the side *BC*, 60, which make 405 $\frac{3}{5}$ of an inch, which is the whole Diameter of the Circle, the half whereof is 202 $\frac{3}{10}$ inches, and something more; near $\frac{1}{2}$, therefore we will avoid the fraction, and account 203 inches, or 16 Foot 11 inches, which is the length of the Sweep, or the side *DE*; and so in all other Sweeps given whatsoever, the Rule is general, and holds true in all things: as to find the Sweep at

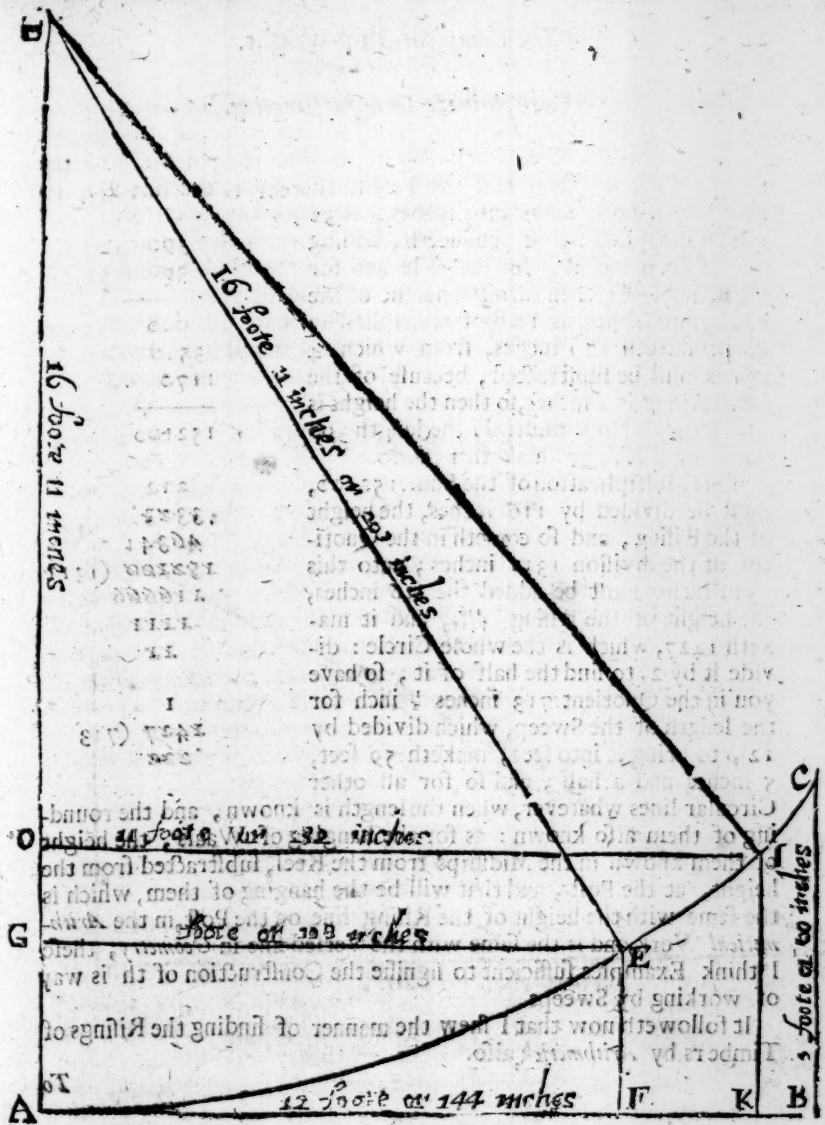
$$\begin{array}{r}
 144 \\
 \times 144 \\
 \hline
 576 \\
 576 \\
 \hline
 20736 \\
 \hline
 20736 \\
 \hline
 60000 \\
 \hline
 60
 \end{array}$$

once, that will round any Beam, or other piece of Timber that is to be Swept, remembring, that if it be a Beam, you are to find the Sweep you take but the half of his length.

Example, As if the Beam be 30 Foot in length, and to round one Foot, you must work by 15, the half length of the Beam; and turn 15 Foot into Inches, by Multiplying 15 by 12, so cometh 180 Inches: remember the length of the Rising line, if it be to find the Sweep, it must be Multiplied by it self, or the half length of the Timber must be Multiplied by it self, as 180 by 180, so cometh 32400, which must be divided by 12 the rounding, cometh in the Quotient 2700, to which must be added the 12 again, the rounding of the piece, and so it is 2712 the whole Circle, the half of this 2712 is 1356 for the length of the Sweep, and so in all other matters where the Sweep is required. This I read in Mr. Gunter's Book, where he calls it the half Chord, being given, and the Versed sine, to find the Diameter, and Semidiameter of the Circle thereto belonging: Now this half Chord in our Work is the length of the Rising line, and the height of the Rising on the Post is that in our Work, which he represents by the name of the Versed sine; where remember to multiply the length of the rising line by it self, if it be a Rising line, and divide by the height of the Rising, and to the Division add again the height of the Rising, so have you always the whole Circle, divide it by 2, so have you the length of the Sweep.

Example

Let the length of the Beam be 30 Foot, and to round one Foot, you must work by 15, the half length of the Beam; and turn 15 Foot into Inches, by Multiplying 15 by 12, so cometh 180 Inches: remember the length of the Rising line, if it be to find the Sweep, it must be Multiplied by it self, or the half length of the Timber must be Multiplied by it self, as 180 by 180, so cometh 32400, which must be divided by 12 the rounding, cometh in the Quotient 2700, to which must be added the 12 again, the rounding of the piece, and so it is 2712 the whole Circle, the half of this 2712 is 1356 for the length of the Sweep, and so in all other matters where the Sweep is required. This I read in Mr. Gunter's Book, where he calls it the half Chord, being given, and the Versed sine, to find the Diameter, and Semidiameter of the Circle thereto belonging: Now this half Chord in our Work is the length of the Rising line, and the height of the Rising on the Post is that in our Work, which he represents by the name of the Versed sine; where remember to multiply the length of the rising line by it self, if it be a Rising line, and divide by the height of the Rising, and to the Division add again the height of the Rising, so have you always the whole Circle, divide it by 2, so have you the length of the Sweep.



Example in the Draught foregoing.

Where the length of the Rising line is from the point *E*, to the point *i*, 32 Foot; and half the height thereof is the line *Di*, 10 Foot: turn both Sums into inches, as 32 Foot multiplied by 12 produceth, adding the $\frac{1}{2}$ foot 6 inches, 390 inches length for the Rising line: then turn the height of the Rising into Inches, as 10 foot multiplied by 12 produceth 120 inches, from which 4 inches must be subtracted, because of the Dead Rising is 4 inches, so then the height is 116 inches: Now multiply the length 390 inches by it self, 390 maketh 152100.

$$\begin{array}{r}
 390 \\
 390 \\
 \hline
 000 \\
 3510 \\
 1170 \\
 \hline
 152100
 \end{array}$$

This Multiplication of the Sum 152100, must be divided by 116 inches, the height of the Rising, and so cometh in the Quotient of the division 1311 inches; unto this 1311 inches must be added the 116 inches, the height of the Rising $\frac{116}{116}$, and it maketh 1427, which is the whole Circle: divide it by 2, to find the half of it, so have you in the Quotient 713 inches $\frac{1}{2}$ inch for the length of the Sweep, which divided by 12, to bring it into feet, maketh 59 feet, 5 inches and a half; and so for all other Circular lines whatever, when the length is known, and the rounding of them also known: as for the hanging of Waals, the height of them known in the Midships from the Keel, subtracted from the height, at the Post, and that will be the hanging of them, which is the same with the height of the Rising line on the Post, in the *Arithmetical* Work, and is the same with the Versed line in *Geometry*; these I think Examples sufficient to signify the Construction of this way of working by Sweeps.

$$\begin{array}{r}
 212 \\
 3323 \\
 46344 \\
 192180 \quad (1311 \\
 116666 \\
 1111 \\
 11 \\
 1 \\
 1427 \quad (713 \\
 222
 \end{array}$$

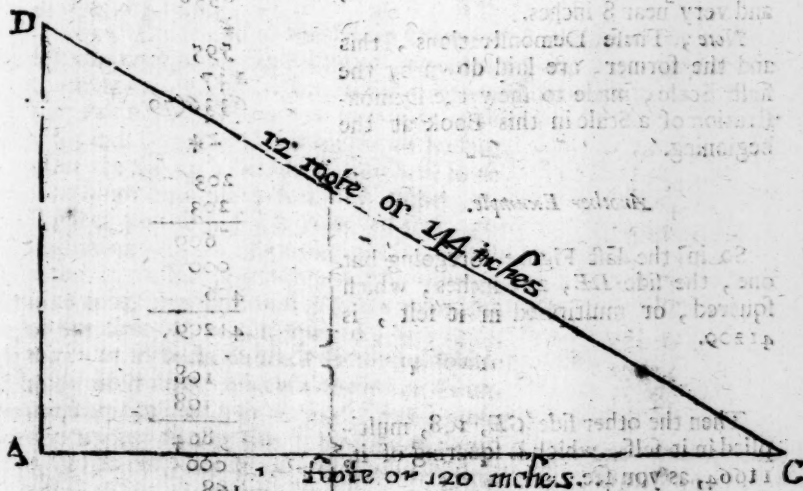
It followeth now that I shew the manner of finding the Risings of Timbers by *Arithmetick* also.

To

To find the Rising of the line FE, in the Figure foregoing.

The Sweep being first found to be as before 203 inches, as the side DE signifieth, then there is known the side EG, 108 inches; now these two sides-being given, we are to find the third side DG, so here is made a right Angled Triangle, two sides thereof are given to find a third, which to do, proceed thus, Multiply the two sides given by themselves, and subtract the Multiplication of the shortest side, from the Multiplication made of the other sides, and extract the square Root of the remainder, so have you the third side sought for.

Example in the following Triangle.



Having

Having the Side *DC*, 12 Foot, which is 144 Inches: and the side *AC*, 10 foot, otherwise 120 inches; to find the side *DA*, multiply the sides given, in themselves, which is called Squaring of them: as, multiply the side *DC*, 144 inches by 144 inches, so cometh 20736. Then multiply the other side *AC* 120 also by it self, so cometh in the Quotient 14400, which must be substracted from the other Multiplication; as you see, so cometh in the Quotient 6336, from which the greatest Square must be extracted, called Extraction of the Square Root, which is 79 inches, and almost another by the Fraction, that is 6 foot, and very near 8 inches.

Note, These Demonstrations, this and the former, are laid down by the first Scale, made to shew the Demonstration of a Scale in this Book at the beginning.

Another Example.

So in the last Figure foregoing but one, the side *DE*, 203 inches, which squared, or multiplied in it self, is 41209.

Then the other side *GE*, 108, multiplied in it self, which is squaring of it, is 11664, as you see.

144
144
576
576
144
20736
120
120
000
240
120
14400
20736
14400
6336
79
395
247
6336(79
24
203
203
609
000
406
41209
108
108
864
000
168
11664

Which

Which subtracted from the other Multiplication, as 11664 subtracted from 41209, resteth 29545, the square Root extracted from it, or the side of the greatest Square that can be taken from the subtraction being found, is 171, and $\frac{1}{2}$, which 171 $\frac{1}{2}$, subtracted from 203, the length of the Sweep for one side, is always the length of the Sweep, resteth 31 inches $\frac{1}{2}$, for the Rising of the line *EF*, and the like for any other Rising.

$$\begin{array}{r} 41209 \\ - 11664 \\ \hline 29545 \end{array}$$

(3
171 (08
29549 (171
21
34

Another Example.

As at the place *KI*, the Rising thereof is required, the side *DI* is as *DE*, 203 inches.

Note. The length of the Sweep being found, always is one of the sides, in the finding the Rising of any Timber, and is always one of the numbers, which, when you have squared, note in a piece of Paper by it self, where you may always see what it is: so that in the finding of Risings, after the Sweep is found, all you have to do, is to know how many feet, or inches, the Timber you seek for is removed from the beginning, or foot of the Rising line, which is the second side, and in this third *Example* it is 11 foot, or 132 inches *KI*, from the foot of the line *A*, which squared, is 17424, which must be subtracted from the square made of Radius, which in the other *Example* is 41209, and so resteth 23785, from which extract the side of the square there in contained, and it is 154 inches and $\frac{1}{2}$, which subtracted from the length of the Sweep, leaveth 48 inches for the Rising, and 48 inches, or 4 foot, and $\frac{1}{2}$ of an inch, and so much is the Rising of the said Timber.

$$\begin{array}{r} 132 \\ 132 \\ \hline 264 \\ 396 \\ \hline 132 \\ 17424 \end{array}$$

41209
17424
23785
154 (69
23789 (154

One *Example* in the *Draught*, the length of that Sweep we found heretofore to be 713 inches, then we will seek to find the Rising for Timber 13, standing aft from the point E, or foot of the Rising line 324 inches, these are the given Sides; then proceed: square the Semidiameter of the Sweep 713, so it maketh squared 508363; then square the distance of the Timber 13, which is 324, and it maketh 104976; these subtracted from the former Figures, resteth 403387, the square Root thereof is 635, nearest, which subtracted from the Radius 713, resteth 77 inches and $\frac{1}{2}$, and that is 6 foot 5 inches, which with 4 inches Dead Rising, is 6 foot 9 inches $\frac{1}{2}$, and so much is the Rising of the Timber 13 from the Keel.

I suppose these *Examples* are sufficient to illustrate the truth and plainness of this *Arithmetical Work*; for the truth of it, it hath this to say for it self, that it is the very exact truth it self: The great *Objection* may be, that many know not the way to Extract the square Root, and therefore cannot attain to this Work by reason of that let or hindrance.

To this I answer, There are many Books that will instruct thee in it, that thou maist buy, or borrow; but to answer thee better, I will briefly shew thee the manner of Extracting the Square, not doubting but thou canst perform Addition, Substraction, Multiplication, and Division already.

C H A P. VIII.

How to Extract the Square Root.

K Now then that a Square number hath its sides equal every way as are the sides of 4, represented by :: pricks; and you see that every way of all the 4 sides it containeth 2, and so 2 times 2, make 4, which is the squaring of a number, so you see 9 pricks is a square, :: or 9 is a square number, whose side is 3; and 3 times 3 make 9, but 2 times 3 is not a square number, as you see :: being but 2 one way, and the other way 3, that make but 6; so then all the numbers be-

tween

tween 4 and 9, are not Square Numbers : by the like reason , a Square made of the next Square Number 4 is 16 , for 4 times 4 is 16 , as by the Pricks you may see it represented here , every of the 4 Sides containing 4 , make a squared Number of 16 , and all the Numbers that are between 9 and 16 , as 2 times 4 , or 3 times 4 , are not Squares , but have a Fraction annexed to them ; so also any Number between 16 and 25 . are not Squares , as 4 times 5 , or 2 times 5 , or 3 times 5 ; these are not Square Numbers , but 5 times 5 is a squared Number , and maketh 25 , where note , that to square a Number , and to extract the square Root , is two different things ; for when we say , to square a Number , it is to multiply it in it self , or by it self ; or when we say , or speak of a Number squared , it is a Number multiplied in it self ; but to extract the square Root , is to find the side of the Square in a Number given , or the extracted square Root is the square Root found in any given Number .



Thus you may conceive of the Squares of 6 , for 6 times 6 make 36 ; 7 times 7 make 49 ; 8 times 8 make 64 ; 9 times 9 make 81 ; 10 times 10 make 100 : there is all the Squares made of the 9 Figures , expressed by this little Table annexed , as against each Figure is the Square made of them , as 2 times 2 is 4 , so is 4 against 2 , as you see .

1	1
2	4
3	9
4	16
5	25
6	36
7	49
8	64
9	81
10	100

Now to extract the square Root from greater Numbers , as from 144 , proceed thus , write down the Sum given , as followeth , and make a Quotient on the right hand , as you see , then set pricks under every other Figure , beginning at the right hand , and set pricks towards the left hand , under every other Figure , so in this Number 144 consisting of 3 Figures , there is 2 pricks , and so many Figures must the Quotient consist of ; then begin at the left hand of the Sum , and say , or enquire for the greatest Square in the

144

Figure or Figures, over the first prick; at the left hand, which here is but 1, therefore you can take but 1, for 1 is always the Square, or Cube of 1, therefore write 1 in the Quotient, and substract that 1 from the 1 over the left hand prick, and cancel it, nothing remaining, write a Cypher over it, as you see, so have you one Figure of the Quotient, then double your Figure found in the Quotient, as 2 times 1 is 2; write that 2 under the Figure between the next pricks, which is the Divisor for the second Figure, then say, how many times 2 can I have in 4, over the Divisor? I say 2, therefore I write 2 in the Quotient, saying, 2 times 2 is 4, which substract from the 4 over head, cancel the Divisor, and the 4 over head, and write a Cypher over it, then square the last Figure found in the Quotient, saying, 2 times 2 is 4, which substract from the 4 over the prick, and so resteth 0, therefore cancel the 4, and write Cyphers over head, signifying that the Number given to find the Root of, is a just square Number, the Root or Side is 12, the Proof hereof is by Multiplication of the Quotient in it self, as 12 by 12 make 144, which if it be the same with the Sum given to be extracted, it is rightly done; if it do not agree, it is not true.

$$\begin{array}{r} 0 \\ 144 \end{array}$$

$$\begin{array}{r} 000 \\ 144 \quad (12 \\ \cdot 2 \end{array}$$

Example of another Sum.

Let 625 be given to find the square Root of it, write down the Sum, make a Quotient, and set pricks under every other Figure; then enquire for the greatest Square in the Figure, over the prick, at the left hand; I say, 2 is the greatest Square can be taken: for 2 times 2 is 4, and here the Figure is but 6, so I write 2 in the Quotient, and square it, saying, 2 times 2 is 4; taken from

$$\begin{array}{r} 2 \\ 625 \end{array}$$

6, so resteth 2; I cancel the 6, and write 2 over it; as you see; then double the Figure in the Quotient, saying, 2 times 2 is 4; this 4 is the second Divisor, I write it between the two next pricks, and say how many times 4 can I have in 22? and I find 5 times; for 5 times 4 is 20, taken from 22, the Figures over 4, so resteth 2; therefore I write 5 in the Quotient, and saying 5 times 4 make 20; therefore I cancel the 4 Divisor, and the 22, and write 2 over head, then square the last Figure found, 5 by 5 make 25, taken from 25 over head, resteth nothing, so the Number given is a square Number.

2
625 (2
·4·
22
625 (25
·4·
22
625 (25
·4·

A Sum of 5476, given to find the nearest square Root in it, write down the Sum, and make a Quotient and prick underneath, as afore shewed; say, What is the greatest Square in the Figures over the left hand prick? and I find it to be 7, for 7 times 7 make 49, but 8 times 8 make 64, 10 too much, therefore I write 7 in the Quotient, and take 7 times 7, that is, 49 from 54, so resteth 5, which I write over the prick, and cancel the 5 and the 4; then I double the Figure in the Quotient, which maketh 14 for the Divisor; I write the first Figure of the Divisor, if there be more than 1 under the Figure, between the two next pricks, and all the other Figures, in their places, towards the left hand; then inquire how many times can 1 be taken from 5, over head, and I find it may be taken 4 times; I write therefore 4 in the Quotient, and say, 4 times 1 is 4, from 5, so resteth 1: I cancel the 1 and the 5, and write 1 over the 5, then I say, 4 times 4 make 16, from 17 resteth 1: I cancel the 4 Divisor, and write 1 over 7, and cancel the other 1 and the 7; then I square the last Figure found,

5
5476 (7
·4·
2
91
5476 (74
·4·
24

for so it must be at every prick, 4 times 4 make 16, which I substract from the 16 over the last prick, and so I see nothing remaineth: that sheweth the Sum given to be a just Square Sum.

0
320
3476 (74
..
24

Example of another Sum.

As if 528363 be given to find the greatest side of the Square therein, I write down the Sum as followeth, and make the Quotient, and set the pricks under every other Figure, as you see; and seeing there is 3 pricks, it telleth, that there must be 3 Figures in the Quotient, then beginning at the Figures, over the left hand prick, I take the greatest Square in 52, and I find it 7, for 7 times 7 make 49; therefore I write down 7 in the Quotient, and substract 49 from 52, so resteth 3, therefore cancel the 52, and write 3 over the 2, as you see; then double the Quotient 7, it maketh 14, for a new Divisor, which write down, the first Figure thereof, under the Figure between the two next pricks, namely 4 under 8, and the other Figure of the Divisor one place farther to the left hand, under the 3, as you see; then take the Divisor 1, as many times as you can, from the Figure 3 over head, so as that after the Division be made, there may be the Square of the last Figure of the Quotient, taken from the Figures over the next prick, as I can take 1 but 2 times from 2; therefore I write 2 in the Quotient, and cancel the Divisor 1, saying, 2 times 14 is 28, from 3; so resteth 1: I cancel the Figure 3 also, and write 1 over head, as you see: then 2 times 4 is 8, from 8 over head resteth nothing; therefore I cancel the second figure of the Divisor, 4 and 8, and write a Cypher over 8, as you see; then the next place being a prick, I must square the

3
528363 (7

14
528363 (7

14
528363 (72

last

last Figure found, saying, 2 times 2 make 4, from 5; the Figure over the prick resteth 1, as you see; therefore I cancel the 5, and write 1 over it, as you see, and here is a Fraction of 101.

Then for a new Divisor, double the Quotient 72, and it makes 144, which is a new Divisor, the first Figure thereof write under the Figure between the next pricks, as the first 4 under 6, in the Sum; and the other Figures towards the left hand, in the order as you see: then how many times 1 in 10 over head, and I see I cannot take 8 times, for that there will not be left to take out the other Figures from, nor for the Square of the last Figure, which if it were 8 would be 64 from the Figure over the prick, therefore I take but 7, for by a light examination I see that will do, therefore I write down 7 in the Quotient, and proceed to the Division thus, 7 times 1 is 7, from 10 over head, remaineth 3, which I write down, and cancel the 10, as you see; then 7 times 4 is 28, from 31 over head, so remaineth 3, which I also write down, and cancel the 31; then again, 7 times 4, the other Figure of the Divisor, is also 28, which taken from 36 over head, resteth 8, which I write down over 6, and so cancel the 36, and then the Sum standeth as you see.

Then lastly, square the last Figure of the Quotient, 7 times 7 make 49, taken from 83, the Figures over the prick, resteth 34, as a Fraction, and the Sum is finished: But in regard here is a Fraction, by that it tells you that the Sum given was no square Number; and the greatest Square therein is 727, the Proof is by Multiplication adding in the

$$\begin{array}{r} 301 \\ 528563 \end{array} (727$$

24

$$\begin{array}{r} 1 \\ 301 \\ 528563 \end{array} (727$$

24 4

24

$$\begin{array}{r} 23 \\ 301 \\ 528563 \end{array} (727$$

24 4

24

$$\begin{array}{r} 233 \\ 301 \\ 528563 \end{array} (727$$

244

24

$$\begin{array}{r} 233 \\ 3028 \\ 528563 \end{array} (727$$

244

24

Fraction

Fraction thus, 727 Multiplied by 727, make 528529, then adding in the Fraction of $\frac{34}{727}$ maketh it 528563, the just Sum given.

But some may object, and say, That this is a very tedious way of Work, and will take up a great deal of time: It is true, it is more Labour than Demonstration, but the truth of it might very plead for patience to Work it, but it is not necessary you perform all the parts by it, that is, in every particular: as the exact hanging of the Waal at every Timber, but it may suffice at every third or fourth Timber, to find the hanging of the Waals, only the Risings Alow, Afore and Aaft, I would work to every Timber there.

But to make it more brief, here followeth a Table that the Numbers are therein contrived to the same purpose, to avoid the tedious Extraction of the Root, and only use Addition and Subtraction, only being but a very little difference between the finding the Risings by this Table, and by the Draught, for in this kind of Arithmetical-Work, it mattereth not, whether there be any Draught drawn at all, or no, if the Builder only note in his Book the length by the Keel, and the breadth at the Beam, the Rack of the Stem, Rack of the Post, depth of the Water, to Sail in depth of the Hould, height of the Waals abaft, afore at the Midships, and all the remarkable things to be noted, he may be able to Build a Vessel, and never draw a Draught at all, and yet affirm his Work to be absolutely true, according to Art, and a great deal more exact than by Draught: I shall in few words shew you the use of the Table, and so conclude.

CHAP. IX.

A Description of the Table of Squares.

TO save the Practitioner a labour of Extracting of Roots, for here they are ready done to thy hand of purpose, and all the use of *Arithmetick* required is only Substraction, as *Example* in the Figure of the Sweep foregoing, being found to be 203 inches, as you saw it found before, which is, I say, always one side of the Triangle, made of the side *DI*, then knowing the length of *od*, 132 inches, which is the distance of the point, of which the Rising is sought at; seek in the Tables, under the Title of inches, at the head of the Tables, for 132, you will find it in the second Page, and the twelfth line; and right against it, in the same lines under the next Title of Squares, you have 17424, the Square made of 132, which subtract from the Square made of 203, which is 41209, which is found in the second Page of the Tables, and the third line; Now the other Number 17424, subtracted from 41209, so resteth 23785; seek the Number nearest to it in the Table, under the Title of Square, which you will find in the second Page, 34 line, you find not just the same Number, for instead of 23785, you find 23716, too little by 59, and the Root answering thereto is in the same line, under the Title of Inches, towards the left hand, which is 154; now if you take the next Square lower to the left hand 35 line, it is 24015, 250 too much, so you may see it is nearer to the 34 line, because there it was too little but by 59, so that you may see it will be $\frac{1}{2}$ of an inch less than the number of inches belonging to the 35 line, and about $\frac{1}{4}$ of an inch more than the numbers in the 34 line; so that you see it is answered, the third side *Do* is 154, and $\frac{1}{2}$ of an inch, which subtracted from the whole Sweep 203 leaveth 48 $\frac{1}{2}$ inches for the Rising, so you have no need of extraction of the Roots by these Tables, it is already done to your hands; the Column that is between the inches and the squares, and written feet, inches in the head, is to shew you, how many feet, and

and inches of the foot any Number of inches is; as here the Number 203 inches sought, and found in the Tables, in the second Page, and third line, just against it, in the same line, between that and the Squares, is 16 — 11, shewing that it is 16 feet and 11 inches; or if the Square were given, as 41209, found at the second Page, and third line, next toward the left hand, you have 16 foot 11 inches; and if you seek for it in inches, in the third Column toward the left hand, and the same line, you have 203 inches: Thus is it very ready to reduce inches into foot measure, or feet into inches.

Another Example.

In the same Figure, to find the Rising at the point *F*, the Sweep being 203 inches, as before is said, is always one side, throughout the whole Work of the same Rising line is 41209, as is found in the second Page, the third line, the other side from the point *AF*, is 9 foot or 108 inches, whose Square is 11664, found in the first Page, and the 28th line; now subtract the Square made of the side *AF*, 11664, from the Square of the side *DE*, so remaineth 29545.

Seek in the Table of Squares for that Number, and I find in the second Page, and 12th line, and the 6th Column, 29584, the nearest Number to it, yet it is a little too much near the 14 of an inch; and toward the left hand in the same line, the next Column under the title *feet inch*, you find 14 3/4 signifying that to be 14 foot, 4 inches: and in one Column more to the left hand, and the same line, you see under the title of *inches* 172, over the head of which must be subtracted from 203 inches, so remaineth 31 inches for the Rising of *EE*, which is 2 foot, 7 inches, as in the first Page of the Table, and in the 31 line.

These few Examples I think may be sufficient to shew the use of the following Tables of the Squares, the benefit whereof may be very great, for such as shall make use of the same: If any desire the finding of the Fractions of these Squares, when he findeth not his just

Figures in the Squares, let him do thus, subtract the Figures under his Number from the Figures above his Number, which shall be the Denominator, then these Figures given, subtracted, from which the next Squares less, shall be the Denominator to that Fraction.

As for *Example*, In the foregoing Figures, after Subtraction, should have been 29533; the nearest agreeing in the Tables, is 29584, the next lesser square Number in the Table is 29241, which is more a great deal too little, than the other is too great; then subtract the lesser square Number 29241, from 29584, and so resteth 343, which must be the Denominator, then again subtract the true Number given, 29553, the next lesser square Number in the Table is 29241, which must be subtracted, I say, from the true Number given 29553, and so resteth after Subtraction 312, which is the Numerator to the Fraction, and must be thus written $\frac{312}{343}$; so then the Number belonging to 29584, is 171 inches and $\frac{312}{343}$ parts of an inch, which being abbreviated, is something more than $\frac{1}{2}$ of one inch, and not full $\frac{1}{2}$ of one inch.

Thus he that pleaseth may find the rising of any Timber, or narrowing of any place by these Tables, and the help of Subtraction, exactly to any Circle whatsoever, but it may suffice, that a Man, going to his Tables, may see which Square his Figures have greatest affinity with, and may estimate the difference near enough without seeking for the Fraction, which will be easily known by much practice herein.

Here followeth a Table of Square Roots, ready Extracted, from one Inch to 1300 Inches, which is 108 Foot, and 4 Inches, and it is thus contrived, That from one Inch, to 840 Inches, all the Inches are reduced into Feet and Inches, for the ease and help of Work-men, who alway take their measure by Feet and Inches; but from thence to the end of the Table you have the Inches only, and the Squares thereof against them, as the Titles over every Page do make appear.

The Compend Ship-wright.

Inch	Feet Inches	Squares	Inch	Feet Inches	Squares	Inch	Feet Inches	Squares
1	1	1	41	3 5	1681	81	6 9	6561
2	2	4	42	3 6	1764	82	6 10	6724
3	3	9	43	3 7	1849	83	6 11	6889
4	4	16	44	3 8	1936	84	7 00	7056
5	5	25	45	3 9	2025	85	7 1	7225
6	6	36	46	3 10	2116	86	7 2	7396
7	7	49	47	3 11	2209	87	7 3	7569
8	8	64	48	4 00	2304	88	7 4	7744
9	9	81	49	4 1	2401	89	7 5	7921
10	10	100	50	4 2	2500	90	7 6	8100
11	11	121	51	4 3	2601	91	7 7	8281
12	1 00	144	52	4 4	2704	92	7 8	8464
13	1 1	169	53	4 5	2809	93	7 9	8649
14	1 2	196	54	4 6	2916	94	7 10	8836
15	1 3	225	55	4 7	3025	95	7 11	9025
16	1 4	256	56	4 8	3136	96	8 00	9216
17	1 5	289	57	4 9	3249	97	8 1	9409
18	1 6	324	58	4 10	3364	98	8 2	9604
19	1 7	361	59	4 11	3481	99	8 3	9801
20	1 8	400	60	5 00	3600	100	8 4	10000
21	1 9	441	61	5 1	3721	101	8 5	10201
22	1 10	484	62	5 2	3844	102	8 6	10404
23	1 11	529	63	5 3	3969	103	8 7	10609
24	2 00	576	64	5 4	4096	104	8 8	10816
25	2 1	625	65	5 5	4225	105	8 9	11025
26	2 2	676	66	5 6	4356	106	8 10	11236
27	2 3	729	67	5 7	4489	107	8 11	11449
28	2 4	784	68	5 8	4624	108	9 00	11664
29	2 5	841	69	5 9	4761	109	9 1	11881
30	2 6	900	70	5 10	4900	110	9 2	12100
31	2 7	961	71	5 11	5041	111	9 3	12321
32	2 8	1024	72	6 00	5184	112	9 4	12544
33	2 9	1089	73	6 1	5329	113	9 5	12769
34	2 10	1156	74	6 2	5476	114	9 6	12996
35	2 11	1225	75	6 3	5625	115	9 7	13225
36	3 00	1296	76	6 4	5776	116	9 8	13456
37	3 1	1369	77	6 5	5929	117	9 9	13689
38	3 2	1444	78	6 6	6084	118	9 10	13924
39	3 3	1521	79	6 7	6241	119	9 11	14161
40	3 4	1600	80	6 8	6400	120	10 0	14400

The Compleat Ship-wright.

38.

Inch	Feet Inches	Squares	Inch	Feet Inches	Squares	Inch	Feet Inches	Squares
121	10 1	14641	161	13 5	25921	201	16 9	40401
122	10 2	14884	162	13 6	26244	202	16 10	40844
123	10 3	15229	163	13 7	26569	203	16 11	41209
124	10 4	15376	164	13 8	26916	204	17 00	41616
125	10 5	15625	165	13 9	27225	205	17 1	42025
126	10 6	15876	166	13 10	27556	206	17 2	42436
127	10 7	16029	167	13 11	27886	207	17 3	42849
128	10 8	16384	168	14 00	28224	208	17 4	43264
129	10 9	16641	169	14 1	28561	209	17 5	43681
130	10 10	19600	170	14 2	28900	210	17 6	44000
131	10 11	17161	171	14 3	29241	211	17 7	44521
132	11 00	17424	172	14 4	29584	212	17 8	44944
133	11 1	17689	173	14 5	29929	213	17 9	45369
134	11 2	17956	174	14 6	30276	214	17 10	45796
135	11 3	18225	175	14 7	30625	215	17 11	46225
136	11 4	18496	176	14 8	31076	216	18 0	46656
137	11 5	18769	177	14 9	31329	217	18 1	47089
138	11 6	19044	178	14 10	31684	218	18 2	47524
139	11 7	19321	179	14 11	32041	219	18 3	47961
140	11 8	19600	180	15 00	32400	220	18 4	48400
141	11 9	19981	181	15 1	32761	221	18 5	48841
142	11 10	20164	182	15 2	33124	222	18 6	49284
143	11 11	20449	183	15 3	33488	223	18 7	49729
144	12 00	20736	184	15 4	33856	224	18 8	50176
145	12 1	21025	185	15 5	34225	225	18 9	50625
146	12 2	21416	186	15 6	34596	226	18 10	51076
147	12 3	21609	187	15 7	34969	227	18 11	51529
148	12 4	21904	188	15 8	35344	228	19 0	51984
149	12 5	22201	189	15 9	35721	229	19 1	52441
150	12 6	22500	190	15 10	36100	230	19 2	52900
151	12 7	22801	191	15 11	36481	231	19 3	53361
152	12 8	23104	192	16 00	36864	232	19 4	53824
153	12 9	23409	193	16 1	37249	233	19 5	54289
154	12 10	23716	194	16 2	37636	234	19 6	54656
155	12 11	24025	195	16 3	38025	235	19 7	55025
156	13 00	24336	196	16 4	38416	236	19 8	55396
157	13 1	24649	197	16 5	38809	237	19 9	55809
158	13 2	24964	198	16 6	39204	238	19 10	56244
159	13 3	25281	199	16 7	39601	239	19 11	56681
160	13 4	25600	200	16 8	40000	240	20 0	57600

Inch	Feet Inches	Squares	Inch	Feet Inches	Squares	Inch	Feet Inches	Squares
241	10 1	5881	231	23 5	78961	321	16 9	10041
242	20 2	58564	282	23 6	79524	312	16 10	103684
243	20 3	59049	283	23 7	80039	323	26 11	104329
244	20 4	59536	284	23 8	80556	324	27 0	104975
245	20 5	60025	285	23 9	81125	325	27 1	105625
246	20 6	60516	286	23 10	81736	326	27 2	106276
247	20 7	61009	287	23 11	82369	327	27 3	106929
248	20 8	61504	288	24 0	82944	328	27 4	107584
249	20 9	62001	289	24 1	83511	329	27 5	108241
250	20 10	62500	290	24 2	84100	330	27 6	108900
251	20 11	63001	291	24 3	84631	331	27 7	109561
252	21 0	63504	292	24 4	85264	332	27 8	110224
253	21 1	64009	293	24 5	85849	333	27 9	110889
254	21 2	64516	294	24 6	86436	334	27 10	111556
255	21 3	65025	295	24 7	87025	335	27 11	112225
256	21 4	65536	296	24 8	87616	336	28 0	112896
257	21 5	66049	297	24 9	88209	337	28 1	113569
258	21 6	66564	298	24 10	88804	338	28 2	114244
259	21 7	67081	299	24 11	89401	339	28 3	114921
260	21 8	67600	300	25 0	90000	340	28 4	115600
261	21 9	68111	301	25 1	90601	341	28 5	116281
262	21 10	68644	302	25 2	91204	342	28 6	116964
263	21 11	69169	303	25 3	91809	343	28 7	117649
264	22 0	69696	304	25 4	92416	344	28 8	118336
265	22 1	70225	305	25 5	93025	345	28 9	119025
266	22 2	70756	306	25 6	93636	346	28 10	119716
267	22 3	71289	307	25 7	94241	347	28 11	120409
268	22 4	71824	308	25 8	94864	348	29 0	121104
269	22 5	72361	309	25 9	95481	349	29 1	121801
270	22 6	72900	310	25 10	96100	350	29 2	122500
271	22 7	73441	311	25 11	96721	351	29 3	123206
272	22 8	73984	312	26 0	97344	352	29 4	123909
273	22 9	74529	313	26 1	97969	353	29 5	124604
274	22 10	75076	314	26 2	98596	354	29 6	125311
275	22 11	75575	315	26 3	99225	355	29 7	126025
276	23 0	76116	316	26 4	99856	356	29 8	126736
277	23 1	76629	317	26 5	100489	357	29 9	127449
278	23 2	77184	318	26 6	101124	358	29 10	128164
279	23 3	77741	319	26 7	101761	359	29 11	128881
280	23 4	78300	320	26 8	102400	360	30 0	129600

The Compleat Ship-wright.

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Inch	Feet Inches	Squares	Inch	Feet Inches	Squares	Inch	Feet Inches	Squares
361	30 1	130321	401	33 5	165801	441	36 9	194481
362	30 2	131044	402	33 6	161604	442	36 10	193354
363	30 3	131779	403	33 7	162407	443	36 11	196249
364	30 4	132495	404	33 8	163216	444	37 0	197136
365	30 5	133225	405	33 9	164025	445	37 1	198025
366	30 6	133956	406	33 10	164836	446	37 2	198916
367	30 7	134689	407	33 11	165649	447	37 3	199809
368	30 8	135424	408	34 0	166464	448	37 4	200704
369	30 9	136161	409	34 1	167281	449	37 5	201601
370	30 10	136900	410	34 2	168100	450	37 6	202509
371	30 11	137640	411	34 3	168921	451	37 7	203401
372	31 0	138384	412	34 4	169744	452	37 8	204304
373	31 1	139129	413	34 5	170569	453	37 9	205209
374	31 2	139876	414	34 6	171396	454	37 10	206116
375	31 3	140625	415	34 7	172225	455	37 11	207025
376	31 4	141376	416	34 8	173056	456	38 0	207936
377	31 5	142129	417	34 9	173889	457	38 1	208849
378	31 6	142984	418	34 10	174724	458	38 2	209764
379	31 7	143641	419	34 11	175561	459	38 3	210681
380	31 8	144400	420	35 0	176400	460	38 4	211600
381	31 9	145161	421	35 1	177241	461	38 5	212521
382	31 10	145924	422	35 2	178084	462	38 6	213444
383	31 11	146689	423	35 3	178959	463	38 7	214369
384	32 0	147456	424	35 4	179776	464	38 8	215296
385	32 1	148225	425	35 5	180625	465	38 9	216225
386	32 2	149006	426	35 6	181476	466	38 10	217156
387	32 3	149769	427	35 7	182329	467	38 11	218089
388	32 4	150544	428	35 8	183184	468	39 0	219024
389	32 5	151321	429	35 9	184024	469	39 1	219961
390	32 6	152110	430	35 10	184900	470	39 2	220900
391	32 7	152881	431	35 11	185761	471	39 3	221841
392	32 8	153664	432	36 0	186624	472	39 4	222784
393	32 9	154440	433	36 1	187789	473	39 5	223729
394	32 10	155236	434	36 2	188396	474	39 6	224676
395	32 11	156025	435	36 3	189025	475	39 7	225625
396	33 0	156816	436	36 4	190006	476	39 8	226576
397	33 1	157609	437	36 5	190960	477	39 9	227429
398	33 2	158404	438	36 6	191044	478	39 10	228484
399	33 3	159201	439	36 7	192721	479	39 11	229141
400	33 4	160000	440	36 8	193600	480	40 0	230400

Inch 481.

Inch	Feet Inches	Squares	Inch	Feet Inches	Squares	Inch	Feet Inches	Squares
481	40	1	231351	521	43	5	271441	561
482	40	2	232324	522	43	6	272448	562
483	40	3	233289	523	43	7	273529	563
484	40	4	234256	524	43	8	274576	564
485	40	5	235225	525	43	9	275605	565
486	40	6	236196	526	43	10	276676	566
487	40	7	237169	527	43	11	277729	567
488	40	8	238144	528	44	0	278784	568
489	40	9	239121	529	44	1	280141	569
490	40	10	2 0100	530	44	2	280900	570
491	40	11	240981	531	44	3	281951	571
492	41	0	242064	532	44	4	284014	572
493	41	1	243049	533	44	5	287089	573
494	41	2	244036	534	44	6	288156	574
495	41	3	245025	535	44	7	286225	575
496	41	4	246016	536	44	8	287296	576
497	41	5	246609	537	44	9	288369	577
498	41	6	247004	538	44	10	290444	578
499	41	7	249001	539	44	11	290521	579
500	41	8	250000	540	45	0	291600	580
501	41	9	251001	541	45	1	292681	581
502	41	10	252004	542	45	2	293764	582
503	41	11	253009	543	45	3	294849	583
504	42	0	254016	544	45	4	295936	584
505	42	1	255025	545	45	5	297025	585
506	42	2	2 6036	546	45	6	298016	586
507	42	3	257049	547	45	7	299209	587
508	42	4	258064	548	45	8	300307	588
509	42	5	260081	549	45	9	301401	589
510	42	6	260100	550	45	10	302500	590
511	42	7	261121	551	45	11	303601	591
512	42	8	262144	552	46	0	304704	592
513	42	9	263169	553	46	1	305809	593
514	42	10	264196	554	46	2	306926	594
515	42	11	265225	555	46	3	308025	595
516	43	0	266256	556	46	4	309136	596
517	43	1	267289	557	46	5	310249	597
518	43	2	268324	558	46	6	311364	598
519	43	3	269361	559	46	7	312481	599
520	43	4	270400	560	46	8	313600	600

Inch	Feet		Squares	Inch	Feet		Squares	Inch	Feet		Squares
	Inches				Inches				Inches		
601	50	1	361201	641	53	5	410881	681	56	9	463761
602	50	2	362404	642	53	6	412164	682	56	10	465124
603	50	3	363609	643	53	7	413449	683	56	11	466489
604	50	4	364816	644	53	8	414736	684	57	0	467856
605	50	5	366025	645	53	9	416025	685	57	1	469225
606	50	6	367236	646	53	10	417316	686	57	2	470596
607	50	7	368449	647	53	11	418609	687	57	3	471939
608	50	8	369664	648	54	0	429904	688	57	4	473344
609	50	9	370881	649	54	1	421201	689	57	5	474721
610	50	10	372100	650	54	2	422500	690	57	6	476100
611	50	11	373321	651	54	3	423801	691	57	7	477481
612	51	0	374544	652	54	4	425104	692	57	8	478864
613	51	1	375769	653	54	5	426405	693	57	9	480249
614	51	2	376996	654	54	6	427716	694	57	10	481636
615	51	3	378225	655	54	7	429025	695	57	11	483025
616	51	4	379456	656	54	8	430336	696	58	0	484416
617	51	5	380689	657	54	9	431649	697	58	1	485809
618	51	6	381924	658	54	10	432969	698	58	2	487204
619	51	7	383161	659	54	11	434281	699	58	3	488601
620	51	8	384400	660	55	0	435600	700	58	4	490000
621	51	9	385641	661	55	1	436921	701	58	5	491401
622	51	10	386884	662	55	2	438244	702	58	6	492804
623	51	11	388129	663	55	3	439569	703	58	7	494209
624	52	0	389376	664	55	4	440896	704	58	8	495616
625	52	1	390625	665	55	5	442225	705	58	9	497025
626	52	2	391876	666	55	6	443556	706	58	10	498436
627	52	3	393129	667	55	7	444889	707	58	11	499849
628	52	4	394384	668	55	8	446224	708	59	0	501264
629	52	5	395641	669	55	9	447561	709	59	1	502681
630	52	6	396900	670	55	10	448900	710	59	2	504100
631	52	7	398161	671	55	11	550241	711	59	3	505521
632	52	8	399424	672	56	0	451544	712	59	4	506944
633	52	9	400689	673	56	1	452829	713	59	5	508369
634	52	10	401956	674	56	2	454276	714	59	6	509796
635	52	11	403225	675	56	3	455625	715	59	7	511225
636	53	0	404496	676	56	4	456976	716	59	8	512656
637	53	1	405769	677	56	5	458329	717	59	9	514089
638	53	2	407044	678	56	6	459684	718	59	10	515524
639	53	3	408321	679	56	7	461041	719	59	11	516961
640	53	4	409600	680	56	8	462400	720	60	0	518400

The Compleat Ship-wright.

Inch	Feet Inches	Squares	Inch	Feet Inches	Squares	Inch	Feet Inches	Squares			
721	60	1	519841	761	63	5	579121	801	66	9	641601
722	60	2	521284	762	63	6	580644	802	66	10	642204
723	60	3	522729	763	63	7	582169	803	66	11	644309
724	60	4	524176	764	63	8	583696	804	67	0	645416
725	60	5	525625	765	63	9	585225	805	67	1	648025
726	60	6	526976	766	63	10	586756	806	67	2	649836
727	60	7	528329	767	63	11	588289	807	67	3	651249
728	60	8	529934	768	64	0	589824	808	67	4	651864
729	60	9	521421	769	64	1	591361	809	67	5	654481
730	60	10	522500	770	64	2	592900	810	67	6	656100
731	60	11	524361	771	64	3	594441	811	67	7	657721
732	61	0	531844	772	64	4	595984	812	67	8	659344
733	61	1	532889	773	64	5	597529	813	67	9	660969
734	61	2	533856	774	64	6	599076	814	67	10	662596
735	61	3	540225	775	64	7	600625	815	67	11	664225
736	61	4	541696	776	64	8	602176	816	68	0	665856
737	61	5	543169	777	64	9	603729	817	68	1	667479
738	61	6	544544	778	64	10	606284	818	68	2	669124
739	61	7	546031	779	64	11	607841	819	68	3	671771
740	61	8	547600	780	65	0	608700	820	68	4	672400
741	61	9	549089	781	65	1	609961	821	68	5	674041
742	62	10	550564	782	65	2	611524	822	68	6	675684
743	62	11	552049	783	65	3	613099	823	68	7	677329
744	62	0	553436	784	65	4	614576	824	68	8	678976
745	62	1	555025	785	65	5	616225	825	68	9	680625
746	62	2	556516	786	65	6	617796	826	68	10	682276
747	62	3	558009	787	65	7	619369	827	68	11	684129
748	62	4	559504	788	65	8	620944	828	69	0	685584
749	62	5	561009	789	65	9	622521	829	69	1	688241
750	62	6	562500	790	65	10	624100	830	69	2	688900
751	62	7	564001	791	65	11	625681	831	69	3	689661
752	62	8	565504	792	66	0	627264	832	69	4	692224
753	62	9	567009	793	66	1	628849	833	69	5	693789
754	62	10	568516	794	66	2	630436	834	69	6	695356
755	62	11	570025	795	66	3	632125	835	69	7	697225
756	63	0	571536	796	66	4	633616	836	69	8	698896
757	63	1	573049	797	66	5	635209	837	69	9	700459
758	63	2	574564	798	66	6	636796	838	69	10	702144
759	63	3	576081	799	66	7	638401	839	69	11	703929
760	63	4	577600	800	66	8	640000	840	70	0	705600

The Compleat Ship-wright.

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Inch	Squares	Inch	Squares	Inch	Squares	Inch	Squares
841	707281	881	777161	921	847241	961	923521
842	708964	882	777924	922	850084	962	926444
843	710649	883	77989	923	851929	963	928369
844	711336	884	781456	924	853746	964	929296
845	714025	885	783225	925	855565	965	931225
846	715716	886	784996	926	857479	966	933156
847	717309	887	786769	927	859329	967	935089
848	719004	888	788544	928	861184	968	937024
849	720801	889	790321	929	863041	969	939061
850	722500	890	792100	930	864900	970	940900
851	724201	891	793081	931	866761	971	942741
852	725904	892	795064	932	868624	972	944784
853	727609	893	797449	933	870489	973	946729
854	729216	894	799236	934	872356	974	948676
855	721025	895	801025	935	874225	975	950625
856	732738	896	802816	936	876096	976	952576
857	734449	897	804609	937	877869	977	954529
858	736164	898	806504	938	879844	978	956484
859	737681	899	808201	939	881721	979	958441
860	739600	900	810000	940	883600	980	960400
861	741321	901	811801	941	885481	981	962361
862	743044	902	813604	942	887364	982	964324
863	744769	903	815409	943	889249	983	966289
864	746396	904	817216	944	891136	984	968256
865	748225	905	819025	945	893025	985	970225
866	749950	906	820836	946	894916	986	972196
867	751689	907	822649	947	896809	987	974169
868	753824	908	824464	948	898704	988	976144
869	755161	909	826281	949	900601	989	978121
870	756900	910	828100	950	902500	990	980100
871	758641	911	829921	951	904401	991	982081
872	760384	912	831741	952	906304	992	984064
873	762129	913	833569	953	908209	993	986049
874	763776	914	835369	954	910016	994	988036
875	765525	915	837225	955	912025	995	990025
876	767376	916	839056	956	913936	996	992016
877	769229	917	840889	957	915849	997	994009
878	770884	918	842724	958	917764	998	996004
879	772641	919	844561	959	919681	999	998001
880	774400	920	846400	960	921600	1000	1000000

G

Inch 100

Inch	Squares	Inch	Squares	Inch	Squares	Inch	Squares
1001	1002004	1041	1082681	1081	1168561	1121	1256641
1002	1004004	1042	1085764	1082	1170724	1122	1258884
1003	1006009	1043	1087849	1083	1172889	1123	1261029
1004	1008016	1044	1089936	1084	1175056	1124	1263376
1005	1010025	1045	1092025	1085	1177225	1125	1265625
1006	1012036	1046	1094106	1086	1179396	1126	1267876
1007	1014049	1047	1096209	1087	1181569	1127	1270029
1008	1016064	1048	1098304	1088	1183744	1128	1272384
1009	1018081	1049	1100404	1089	1185924	1129	1274641
1010	1020100	1050	1102550	1090	1188100	1130	1276900
1011	1022121	1051	1104661	1091	1190281	1131	1279161
1012	1024144	1052	1106764	1092	1192464	1132	1281434
1013	1026169	1053	1108869	1093	1194649	1133	1283669
1014	1028196	1054	1110916	1094	1196836	1134	1285956
1015	1030225	1055	1113025	1095	1199025	1135	1288225
1016	1032256	1056	1115136	1096	1201216	1136	1287496
1017	1034289	1057	1117249	1097	1203409	1137	1292769
1018	1036324	1058	1119364	1098	1205604	1138	1294994
1019	1038361	1059	1121489	1099	1207801	1139	1297321
1020	1040400	1060	1123600	1100	1210000	1140	1299640
1021	1042441	1061	1125721	1101	1212201	1141	1301861
1022	1044484	1062	1127844	1102	1214404	1142	1304164
1023	1046529	1063	1129969	1103	1216609	1143	1306449
1024	1048576	1064	1132096	1104	1218816	1144	1308736
1025	1050625	1065	1134225	1105	1221025	1145	1311025
1026	1052676	1066	1136356	1106	1223236	1146	1313316
1027	1054729	1067	1138489	1107	1225449	1147	1315509
1028	1056784	1068	1140624	1108	1227664	1148	1317904
1029	1058841	1069	1142761	1109	1229881	1149	1320201
1030	1060900	1070	1144900	1110	1232100	1150	1322500
1031	1062961	1071	1147041	1111	1234321	1151	1324801
1032	1065024	1072	1149184	1112	1236544	1152	1327104
1033	1067089	1073	1151329	1113	1238769	1153	1329409
1034	1069156	1074	1153476	1114	1240996	1154	1331716
1035	1071225	1075	1155625	1115	1243225	1155	1334025
1036	1073296	1076	1157776	1116	1245456	1156	1336336
1037	1075369	1077	1159929	1117	1247689	1157	1338649
1038	1077444	1078	1162074	1118	1249924	1158	1340964
1039	1079521	1079	1164241	1119	1252161	1159	1343381
1040	1081600	1080	1166400	1120	1254400	1160	1345600

Inch	Squares	Inch	Squares	Inch	Squares	Inch	Squares
1161	1347921	1196	1430416	1231	1515361	1266	1602756
1162	1350244	1197	1432809	1232	1517824	1267	1605289
1163	1352569	1198	1435204	1233	1520289	1268	1607814
1164	1354396	1199	1437601	1234	1522856	1269	1609361
1165	1357225	1200	1440000	1235	1525325	1270	1611900
1166	1358556	1201	1442401	1236	1527696	1271	1614441
1167	1361689	1202	1444804	1237	1530169	1272	1617084
1168	1364124	1203	1447209	1238	1532444	1273	1620329
1169	1366921	1204	1440616	1239	1535121	1274	1622276
1170	1368900	1205	1451025	1240	1537600	1275	1625025
1171	1371240	1206	1454436	1241	1540081	1276	1628172
1172	1373584	1207	1456849	1242	1542564	1277	1630729
1173	1375929	1208	1459264	1243	1545049	1278	1633464
1174	1378276	1209	1461681	1244	1547536	1279	1635841
1175	1380625	1210	1464100	1245	1550025	1280	1638400
1176	1382979	1211	1466521	1246	1552516	1281	1640961
1177	1385329	1212	1468944	1247	1555009	1282	1643524
1178	1387784	1213	1471369	1248	1557504	1283	1645989
1179	1390041	1214	1473796	1249	1560001	1284	1648656
1180	1392400	1215	1476225	1250	1562500	1285	1651225
1181	1394761	1216	1478656	1251	1565001	1286	1653796
1182	1397124	1217	1481089	1252	1567504	1287	1656369
1183	1399489	1218	1483524	1253	1570009	1288	1658944
1184	1401856	1219	1485961	1254	1572416	1289	1661521
1185	1404225	1220	1488400	1255	1575025	1290	1664100
1186	1406606	1221	1490841	1256	1577536	1291	1666681
1187	1408969	1222	1493244	1257	1580049	1292	1669264
1188	1411324	1223	1495729	1258	1582564	1293	1671849
1189	1413711	1224	1498246	1259	1585081	1294	1674336
1190	1416100	1225	1500725	1260	1587600	1295	1677025
1191	1418481	1226	1503276	1261	1590121	1296	1679616
1192	1420864	1227	1505729	1262	1592644	1297	1682209
1193	1423249	1228	1508184	1263	1595169	1298	1684804
1194	1425639	1229	1510641	1264	1597706	1299	1687401
1195	1428025	1230	1513096	1265	1600225	1300	1690000

of the Rudder is a story length, and they make
 good which the Diameter of the whole Circle
 and half thereof is 346 inches, which is 29 feet, as you may see by
 dividing it by 12, or else, if you turn to the Table, and look under
 the Column for 346, you will find the same line, towards the
 left.

C H A P. XI.

Shewing how to bang a Rising-line by several Sweeps, to make it rounder aftward; than at the beginning of the same.

IF any be desirous to have a Rising-line rounder aftward than it is at the fore part of it, they must proceed thus: First Work by the Sweep that they would have first, and then begin again, and find the other Sweep, that they would have the roundest: An *Example* of this will make it more plain, as in the following Figure will appear.

Let *DE* represent the length of a rising-line *EL*, the height thereof 8 foot, on the after end thereof: First, I find the Sweep that Sweepeth it, by multiplying of 20 foot the length, which is 240 inches; for if you look in the Tables under the Title of *Feet inches*, for 20 feet, you will see in the next Column, toward the left hand, 240; over head is written Inches, signifying, that in 20 feet is 240 inches; and just against it, and in the same line, towards the right hand under the Title of *Squares*, you will see written 57600, signifying, that the Square of 240 is 57600, these Numbers you will find in the second Page of the Tables, and the last line, the seventh, eighth, and ninth Columns.

This squared Number 57600, made by the Multiplication of *DE*, 240 inches must be divided by the height of the Rising line assigned *EL*, 8 foot; or 96 inches, so remaineth in the Quotient 600, to which must be added the height of the Rising, as is afore taught, and they make 696, which is the Diameter of the whole Circle; the half thereof is 348 inches, which is 29 foot, as you may see by dividing it by 12; or else, if you turn to the Tables, and seek under the Title of *Inches* for 348, you will see in the same line, toward the

0
20
57600 (600
9666
98

left

left hand 29 feet, which you will find in the third Page, and the 28th line, the seventh and eighth Column; then I work by that Sweep to $\frac{2}{3}$ of the length of the Rising-line, or 12 foot of the same; at the point *C* it is represented, at which point I seek the Rising *CB*, I seek in the Table for the Square made of 144, and I find it in the second Page, 24 line, at the first Column; and towards the right hand under the Title of Squares, I find 20736, which is the Square made of 144: then I seek for the Square made of the Sweep, or the side *AB*, 348 inches, and I find it in the Tables to be 121104, from this 121104 I subtract the other Square, made of the side *DC*, 144 being 20736, and there remaineth 100363, whose Root I find in the Tables, in the third Page, and the 37th line, and the sixth Column, 100489, which is too much by near 121; but the other Number afore it being much more too little, the Number answering hereunto is 316 inches, and near $\frac{1}{2}$, Subtracted from 348, the whole side leaveth 31 inches $\frac{1}{2}$, or 2 foot 7 inches $\frac{1}{2}$ for the Rising at the point *C*: Now to make a rounder Sweep afterward on, or at the other end of the line, as from *B* to *F*, which runneth higher up, or Roundeth more, as from *I* to *F*: Here will be something more of trouble to find the Sweep that shall exactly touch the two points assigned, as from *BF*, than to find the former Sweep. Now the Demonstration will shew it to be thus.

121104

20736

100363

Let

with the Subtending side BF ; then a streight line drawn from the middle of the side BF , and perpendicular, or square, to the same line BF , and extended, till it touch the side DA , the place where it toucheth shall be the Center of the same Sweep, as is the line GH , passing through the middle of the side BF , at the point O , which to find Arithmetically, proceed thus. Find first the length of the side BF , as before is taught, of two sides of a Right angled Triangle given, to find the third side, which will be found to be $134\frac{1}{2}$ inches, the half whereof is 67 inches; from B to O , then if a perpendicular be let fall from O to the line BH , it will cut that Base line also in halves, as at the Point P being 48 inches: Then again, find the side OH , and that will be, in this Example, equal to the side BO , but in other cases it may not so fall out: So then those 2 sides being known, as the side OH , $67\frac{1}{2}$ inches and the side PH , 48 inches, and the whole length of the side KH , 240 inches, you may then Work by the Rule of Three, saying, if 48 , the side PH give $67\frac{1}{2}$ inch for the side OH , what will 240 give, for the KH , as thus,

240	2	
67	144	
<hr/>	4640	
If 48 give $67\frac{1}{2}$, what will 240?	1680	16080 (335
	1440	4888
	<hr/>	44
	16080	

If you multiply the two last Numbers together, and divide the first Number, you will beget in the Quotient 335 , for the length of the whole side GH .

I here neglected the $\frac{1}{2}$ inch in this Multiplication, for the $\frac{1}{2}$ inch should have been Multiplied into the 240 , by adding to the Sum 16080 , 120 , the half of 240 , and it maketh 16200 , which divided by 48 , maketh $337\frac{1}{2}$ inches for the whole side GH ; So then these two sides being found, find the side GK , thus, as before is taught, look in the Table of Squares for the Square made of the side 337 , and it will be 113569 , from which Subtract the Square made of 240 , the

113569
<hr/>
57600
<hr/>
55969

other.

other side being 57600, there resteth 55969; as you may see, for that Number sought for in the *Tables*, and you find the nearest Number to it, to be 56069, and the Root of it to be 237, for the side *OK*, to which must be added the Rising of the point *CB*, or *KD*, which is all one, and is as we found it before to be, $31\frac{1}{4}$ inches added to 237, maketh $268\frac{1}{4}$ inches, or 22 foot 4 inches; shewing, that at 22 foot 4 inches, from the point *D*, towards *G*, will be the point where the Center of the Rounder Circle ought to stand: Then again, you have the side *GK*, found as before to be 237, and the side *KB* 144, and if you work as is taught before; but remember that if the longest side be sought for, as is now in the last side sought for, *GB* being the longest side, you must add the Squares made of the other 2 sides together, and the Square of those 2 Sums shall be the longest side *GB*, 277 inches, that is 23 feet 1 inch, which is the length of the second Sweep, and so have you the length of the Sweep. The same order you may observe to round your Sweep, as often as you please.

$$\begin{array}{r} 237 \\ 31\frac{1}{4} \\ \hline 268\frac{1}{4} \end{array}$$

If any have knowledge of the Doctrine of *Triangles*, it may be found more ready: that I leave to those that know the use thereof.

Note also, that when you seek for any Number in the *Tables*, take heed that you mind the Number of Figures you seek for, to agree in Number with those that direct you to seek for them.

As for *Example*, In the other Figures above mentioned, 55969, they are in Number 5, by their places, as you see; then repairing to the Table, I find 559504; but telling the Figures, I see they are in Number 6, but should be but 5: therefore this Number, represented in the seventh Page, and the 28th line, and third Column, is not the place I seek for; then I turn toward the beginning of the Table, till I see that the Columns of *Squares* contain but 5 Figures, and there seek the nearest Number agreeing to 55969; and in the second Page, 37th line, last Column, I find 56069, the nearest agreeing to it, which is the place answering to the other directory Figures.

Note also, That the *Example* of finding the Sweep aforegoing, is laid down by a small Scale of the *Dranght*, by which you may try it for your better directions.

And in that Table you may see that any farther than 70 foot, being the end of the 7th Page, I have not mentioned the Feet and Inches belonging to the number of Inches, but have left it out because they are of little use any further, because that will reach far enough for the length of any Rising line of any Ship whatever. If any be desirous to convert any of the following Numbers into Inches, he may do it by dividing by 12.

Thus I think I have spoken enough to the Ingenious, concerning the singular use of the Tables, or of this way of working by Segments or Circles.

CHAP. XII.

Concerning Measuring of Ships.

I Shall say something concerning it: The Ship-wrights have to themselves a custom of measuring at London, or on the River of Thames, thus, they multiply the length of the Keel into the breadth of the Ship, at the broadest place, taken from outside to outside, and the product of that by the half breadth, this second product of the multiplication they divide by 94, or sometimes 100, and according to that division, is the Quotient thereof; they are paid for so many Tuns; as suppose in the former Draught being in length 60 foot, and 20 foot broad, being multiplied by 20, the breadth produce 1200, and 1200 again multiplied by 10, the half breadth produce 12000, if you divide by 100 you need do no more than cut off the two last Figures toward the right hand, which shall be the answer and rendreth the Ship to be 120 Tuns, but if you divide the Sum 12000 by 94, you will have 127 $\frac{2}{3}$ of a Tun very near; but this cannot be the true ability of the Ship to carry or lift, because two Ships by this rule of equal breadth and length shall be of equal burthen, notwithstanding the fulness or sharpness of those Vessels, which may differ them very much, or the one Ship may have more timber than the other in her building, and so shall carry less than the other; But the true way of measure must be by measure

of the body and bulk of the Ship under water; for if one Ship be longer in the floor than another of the same breadth and length, she shall be more in burthen than the other; as a Flemish Ship shall carry more than a French or Italian Vessel of the same length and breadth: Therefore I say the measure of the Ship being known by measuring her, as a piece of Timber may be measured of the same form, to the draught of water assigned her, the weight of the same body of the same water that the Ship swimmeth in, shall be the exact weight of the Ship, and all things therein, loading, rigging, victuals included therein: then if the Ship be measured to her light mark as she will swim at being lanced, the weight of so much water being taken or subtracted from the weight of the water when she is laden, the residue shall be the weight that must load her, or her ability of carrying, called her burthen: by this means you may know the weight of the Ship light, and what she will carry to every foot of water assigned to her, which can be done by no general rules in Arithmetick, because of their great irregularity, according to the differing minds of Ship-wrights; you may if you please first measure the content of the Keel and Post and Stern-rudder, all of it that is without the Plank, and under the water-line, and note it by it self, then measure the body of the Ship in the Mid-ships, made by the square made of the multiplying of the depth of the water-line, and the breadth, then you may find the content of the water by the circular part of the Ship under water, being narrower downward, and subtract this from the whole content of the squared body of the depth of the water line and breadth of the Ship, and this shall be the solid content of that part of the Ship, I mean in solid foot measure of 1728 inches to the foot, then proceed to the fore-part or the after-part of the Ship, and to 3 or 4 Timbers more, find the mean breadth at the narrowing aloft at the water-line, and allow at the floor and the mean depth, and measure that piece of the Ship, as I told you of the middle part of the Ship, and so measure the whole Ship by pieces, and add them together, and so many feet as it maketh, so many feet of water shall be the weight of the said Ship; and the reason may be considered thus: there is a ponderosity in the water, but there is a greater in the Air; only to the heaviest of things, and there is a ponderosity in the water it self, but not so much as in other things more solid, as in Iron; Suppose a
Gun

Gun or an Anchor of Iron, it sinketh in the water; but yet it is not so heavy in the water as in the Air, by the weight of so much water as shall make a body of the same water equal to the body of the Gun or Anchor in magnitude; which weight subtracted from the weight of the Iron body weighed in the Air, and so much must be the weight of it in the water.

Again, if a body be lighter in weight than water of the same bigness, it hath an ability of lifting in the water, and can lift or carry so much as is that difference, as a piece of cork or wood of Fir-trees, being lighter than water, it swimmeth on the face of the water, and refuseth to be depressed without more weight added to it.

Thus a Ship being a concave body, is made capable of lifting according to the greatness or littleness of this concavity, respect being had to the greatness of the Timber put into it, or the nature of it, all which maketh a Ship swim deeper or lighter in the water.

I have proved by the Thames water, that fresh water is lighter than salt water; so then salt water being heavier than fresh, causeth that a Ship swimmeth deeper in the fresh water than in salt.

I shall not need to say any thing more concerning the measuring, for it will be understood by those that have any judgment in the measuring of Triangles, the matter itself being but a nicety rather than useful: I only touched it, to shew those that are so curious minded, which way they may accomplish their desires: I shall forbear to give Examples, because it will much increase my Treatise, and augment the Price, which might prove more prejudicial to young men, than advantageous.

C H A P. XII.

Concerning the Masts of Ships.

FROM the length and breadth is gained the Main-masts length, and all the other Masts, as well as Yards, are derived from thence, and there is different proceedings in this case, according to the largeness of the Ships; thus the Main-masts of small Ships to be three times as long as the Ship is in breadth; as a Ship of 20 foot broad, by the same rule must have a Mast of 60 foot long.

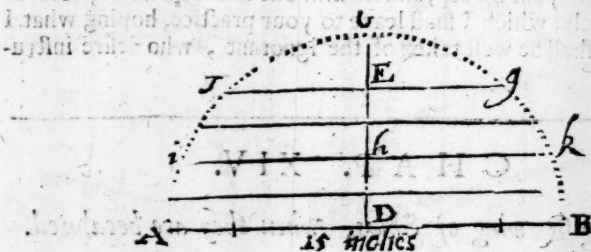
Others for greater Ships add the breadth to the length, and to that the half breadth, which Sum they divide by 5, and the Quotient is the number of yards, as a Ship 114 foot long and 34 foot in breadth, as the breadth added to the length, and the half breadth added together, make 165, that divided by 5, yields 33, and so many yards is the length to be of that Mast; the Fore-mast must be a yard shorter at the head. That is to say, besides the height of the step, which commonly in most Ships the step of the Fore-mast standeth higher from the bottom of the Ship than the step of the Main-mast; the Fore-mast must be shorter by that difference, and one yard more, on the bigness of the Ship considered, 14 foot shorter at the head, or besides the difference below.

The Top-masts two thirds of the length of the lower Masts. The Main-yard to be $\frac{2}{3}$ of the Main-mast, as in the Mast aforementioned of 60 foot long, two thirds of 60 is 40, and the $\frac{1}{3}$ of 60 is 20, added to 40 makes 60, for the length of the Main-yard. The Fore-yard to be $\frac{2}{3}$ of the Main-yard, as the Main-yard being 45 foot, divide 45 by 3, so cometh 15 in the Quotient, and a Fraction remaining of 3, signifying $\frac{1}{3}$, so that the $\frac{2}{3}$ of 45 will be 30 and 10, you must take 6 times so much, as 6 times 6 makes 36, and if you take 6 times 10, make 60, that is two whole Numbers and $\frac{2}{3}$ remaining, which added to 36, make 96, and $\frac{2}{3}$ of a foot for the length of the Fore-yard. The Top-sail Yards must be half the length of the lower Yards, the Mizzen-yard usually is made of equal length with the Fore-yard, the Cross-jack yard of equal length with the Main-top-sail yard, and the Mizzen-top-sail yard to be half the length of the Cross-jack yard.

The Mizzen Mast to be of the length of the Main-top-mast from the upper Decks, and so much longer as is the height of the Ship between Deck, the Bolt-spreet to be of length equal to the Fore-mast from the upper Deck of the Fore-castle upwards.

For the bigness of these Masts, 10 a yard in length $\frac{1}{4}$ of an inch, or else $\frac{1}{4}$ of an inch to the foot, and so of yards likewise, only the Bolt-spreet something bigger, would be the better if he be made as big as the Fore-mast.

The Sprit-sail yard in length $\frac{3}{4}$ of the Bolt-spreet, the Sprit-sail top-sail yard as of the rest, to be $\frac{1}{2}$ the Sprit-sail yard, the Mizzen yard in bigness, but $\frac{1}{4}$ inch to a yard: And directing my course to Young men that desire Instructions, I will avoid troubling of them as near as I can with Arithmetick, therefore I will shew them the sweeping out of Masts and Yards, for the filling up of their Quarters according to Circles. Thus, make a half Circle equal in Diameter to the bigness of the Mast, in the partners, or if it be a Top-mast, equal to his bigness in the Cap; as suppose for to make a Mast 60 foot in length, then by the former directions $\frac{1}{4}$ of an inch for his bigness to a foot, rendreth



him to be 15 inches thorow, but for a Main Mast it is always better that they be made bigger, to every 6 inches add $\frac{1}{2}$ of an inch more, so then this Mast will be 16 $\frac{1}{2}$ inches, I make a Sweep of 16 $\frac{1}{2}$ inches, as from A to B, supposing the feet of the small Scale to be inches, draw the Sweep or Arch ACB, 15 inches from A to B; then at the Centre draw a line perpendicular to AB, as from D to C, divide the perpendicular into four equal parts, with the Compasses, and set off three of them, on the perpendicular from D to E; and through that point draw a line parallel to AB, as is the line fg, which shall be the bigness of the Mast at the Hounds, then middle the space between D and E, as at h, and draw the line ik, which shall be the bigness of the Mast at the middle, then two other lines drawn again through the middle between Dh and another between hE, shall be the bigness of the Mast in the quarters, so then take off from the Sweep, the bigness at each place from the middle line DC, to the Arch, and in like manner

manner middle the Mast from the Partners to the Hounds, and quarter it, and strike a middle line from end to end, and at each place set off the thickness given you by your Sweep, for the length of the Heads of the Masts you may allow to every foot 1 inch $\frac{1}{2}$ of an inch from the head to the upper part of the Cross-trees, the length of the Trestle-trees to be $\frac{1}{2}$ of the Ship's breadth, and in depth half the thickness of the Head, at the Hounds, and for the thickness, half the thickness of the Head, at the very end of the Head of the Mast: for Yards you may draw the Sweep of them to their bigness at the Slings, and let the ends of them be but one third of the bigness in the Slings, accordingly draw your Sweep, and fill him out in the quarters, according to the Circle, which I shall leave to your practice, hoping what I have spoken shall be well taken of the ignorant, who desire instructions.

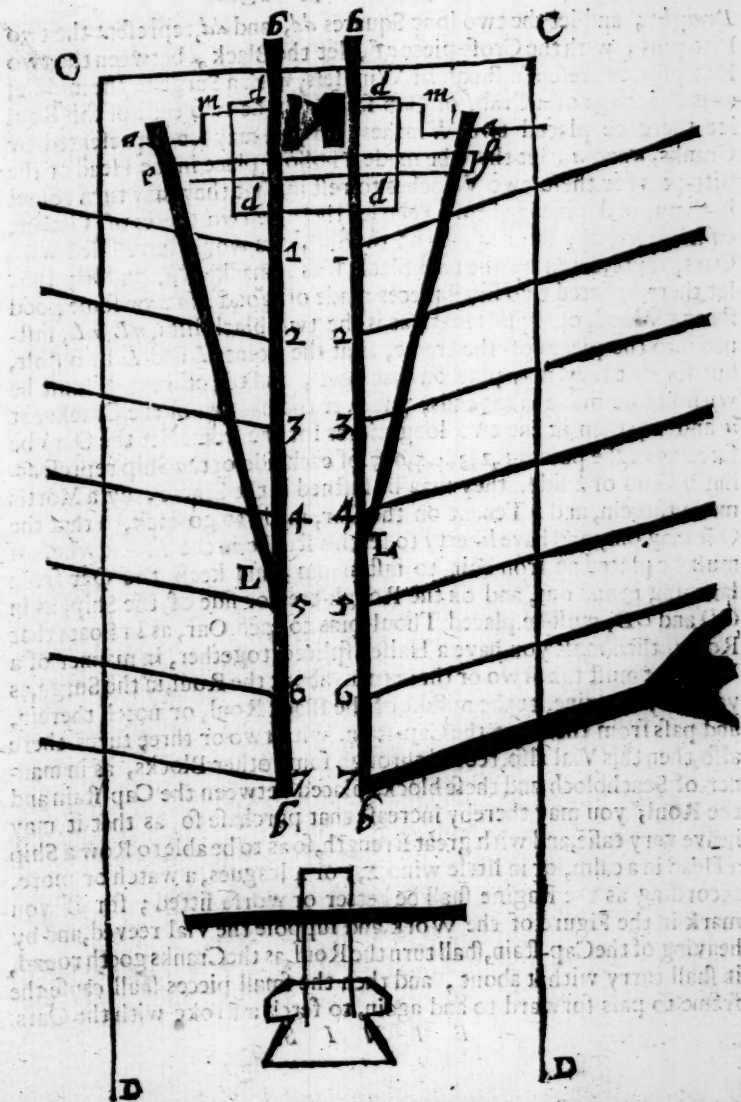
C H A P. XIV.

Concerning Rowing of Ships, when they are becalmed.

I Have here invented a means of Rowing of a Ship, by the heaving at the Capstain, where will be many benefits: First, of a greater purchase of strength, for it is evident, that 16 men at a Capstain shall heave a Ship a Head, when thirty men shall not Haal her a Head by hand, say 50, neither shall they be so soon tired, for that Oars are a great weariness to the Arms, beside a double motion of the body, as when the stroak is fetched, to weigh down the Oar, that the blade may be elevated out of the water, where it must be kept so until another stroak be fetched, and then great strength put to the Oar by the Arms, or else heavy bodies will not be moved: beside, if you have never so many Oars as you can put, they all fetch their stroak at once, but when Rowed by hand, one is likely to fetch a stroak before another, so that much of the strength is lost by a disagreement in the labour. But to proceed to the description of this invention.

Let therefore two lines, *CD*, and *CD*, represent the sides of the Ship, 16 foot broad, as is the line *CC*, 16 foot long, by the Scale of the

Draught;



Draught ; and let the two long Squares *dd*, and *dd*, represent the two Bitt-pins, with the Cross piece *ef*, let the Black, between the two Bitt-pins, represent a Roul, or Windleſs, with a Surge in the middle, as is the Surge of a Crab, or Cap-ſtain ; in the two ends of this Roul let there be placed two Winches, as you may ſee represented by Cranks, *n* and *a* ; let there be made a hollow place in the Head of the Bitt-pins for theſe two Winches to reſt in, that they may turn round in them, and hide in them : then let there be two pieces of Timber, equal in length, to the ſpace of the Ship you would have filled with Oars, represented by the two black liſts, marked *bb*, and *bb* ; then let there be fitted two ſmall pieces made of good Aſh, or ſome good ſtrong Wood, of equal length as is the two black liſts, *nL*, *mL*, faſtened into the pieces of the frame, as at the points *L* and *L*, by a Bolt, but ſo, that they may play on that Bolt ; and the other ends muſt be with a Hole made in the ends, put over the handles of the Cranks, at *n* and *m*, then in the two long pieces for the frame let the Oars be fixed as at the points 1, 2, 3, 4, 5, 6, 7, of each ſide of the Ship representing 7 Oars of a ſide, they may be faſtened in the Frame, by a Mortis made therein, and a Tenent on the Oar, made to go ſlack, in that the Oar may play and have liberty to fetch a ſtroke, in the middle whereof muſt be placed an Iron bolt, to faſten him, and keep the Oar from launching in and out, and on the Rough-tree, or ſide of the Ship, as in *CD* and *CD*, muſt be placed Thoul-pins to each Oar, as in Boats that Row ; then muſt you have a Halſer ſpliced together, in manner of a Vial, that muſt take two or three turns about the Roul, in the Surge, as you may imagine, at the middle of the Black Roul, or notch therein, and paſs from thence to the Cap-ſtain, with two or three turns there alſo, then this Vial alſo, reeved through ſome other Blocks, as in manner of Snachbloch, and theſe blocks placed between the Cap-ſtain and the Roul, you may thereby increaſe that purchaſe ſo, as that it may heave very eaſie, and with great ſtrength, ſo as to be able to Row a Ship a Head in a calm, or in little wind 2, 3 or 4 leagues, a watch or more, according as the Engine ſhall be better or worſe fitted ; for if you mark in the Figure of the Work, and ſuppoſe the Vial reeved, and by heaving of the Cap-ſtain, ſhall turn the Roul, as the Cranks goeth round, it ſhall carry with it about, and then the ſmall pieces ſhall cauſe the frame to paſs forward to and again, to fetch a ſtroke with the Oars.

